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THE S WAVE PROJECT FOR FOCAL MECHANISM STUDIES

EARTHQUAKES OF 1963

by

WILLIAM STAUDER, S.J., and G. A. BOLLINGER

A Scientific Report
Prepared under Grant AF-AFOSR 62-458
with the Air Force Office of Scientific Research
Project VELA-UNIFORM

Department of Geophysics and Geophysical Engineering
Institute of Technology
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ABSTRACT

This is the second report of the S Wave Project, a routine program instituted by the Department of Geophysics of Saint Louis University for the determination of the focal mechanism of the larger earthquakes of each year using methods developed for the use of S waves in focal mechanism studies. In addition to the methods of data analysis described in detail in the previous report for earthquakes of 1962, in studying the earthquakes of 1963 use has also been made of a computer program. The program uses an error surface to search for the position of the axes of a double couple which gives the least standard deviation of the S wave polarization data.

Seventy-two earthquakes of magnitude $> 6\frac{1}{4}$ occurred during 1963. Of these thirty-five earthquakes, so located as to afford a distribution of seismographic stations favorable for the use of S wave data, were selected for examination. Satisfactory focal mechanism solutions are here presented for twenty-six of these shocks. Tentative solutions are given for six, and no solution is advanced for the remaining three.

Data have been more numerous for the study of the earthquakes of 1963 as compared to those of the previous year, but the general quality of the data and reliability of the solutions remains unchanged. Earthquakes in three regions are selected for special note: Kurile Island earthquakes, two deep focus earthquakes of Brazil, and three North Atlantic earthquakes. The latter occurred along the mid-Atlantic ridge; their respective mechanism diagram indiate the principal tensional axis to be nearly horizontal and normal to the local trend of the ridge.

THE S WAVE PROJECT FOR FOCAL MECHANISM STUDIES

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I. Introduction

In the fall of 1962 the Geophysics Department of Saint Louis University initiated a routine program for the investigation of the focal mechanism of earthquakes using data from the S waves of earthquakes, supplemented by data concerning the first motion of P. The program is identified as <u>The S Wave Project for Focal Mechanism Studies</u>. A first report of the project, covering earthquakes of 1962, was published a year ago (Stauder and Bollinger, 1964a, b). This is the second comprehensive report, presenting the data and focal mechanism solutions for selected larger earthquakes of 1963.

The scope and purpose of the S Wave Project, as also the theory and techniques of data interpretation, were described in detail in the previous report and will not be repeated here. In general, the program aims to investigate in what way the radiation pattern of S waves is related to the orientation and character (e.g. single couple vs double couple point source equivalent) of the earthquake focus and, by incorporation of the S wave data into the procedure of determining nodal planes of P wave first

motion, to obtain more reliable determinations of the focal mechanism. The project is of significance to VELA-Uniform first because by these studies new insight is obtained into the nature of earthquake sources (as opposed to explosions) and into the character of the S waves generated by earthquakes. Secondly, these studies inquire into the existence, if any, of distinctive characteristics of earthquakes in a given region. The project is also of more general, long-term interest to seismology, for it provides material for statistical studies of the causes of earthquakes and of the tectonics of active seismic regions.

The project uses as its primary data source 70 mm microfilm copies of records from the World Wide Standard Station Network supplied by the Seismology Division of the United States Coast and Geodetic Survey. The WWSS 70 mm film copies have been found to be ideally suited to these investigations. The authors gratefully acknowledge the assistance and cooperation of the U. S. Coast and Geodetic Survey in promptly and carefully providing the film copies.

II. Earthquakes Selected

The epicentral distance range within which the S wave polarization can be determined with confidence, together with the requirement for azimuthal coverage of data points about the source, place restrictions on the geographic location and magnitude range of earthquakes which can be used effectively for mechanism study by the use of S wave data

(see Stauder and Bollinger, 1964a, Appendix I, pp. 28-30). In the selection of earthquakes for study, a listing was made of all earthquakes of magnitude 6.1 and greater as determined by the USCGS and published in the "Preliminary Determination of Epicenters." Seventy-two earthquakes were so obtained for the year 1963. Of these, on the basis of geographic location of the epicenters and of the distribution of stations relative to the epicenters, thirty-five were selected for examination. These thirty-five shocks are listed in Table 1, and their locations are indicated on the index map of Figure 1. The thirty-seven earthquakes which were judged less suitable for investigation are listed in Table 2. The tables list the date of occurrence, origin time, latitude and longitude of the epicenter, focal depth (h), Gutenberg-Richter region (Reg), magnitude (m_b, published by USCGS), and descriptive geographic location.

III. Preparation of Data and Interpretation

For each of the earthquakes of Table 1 70 mm microfilm records were requested for selected stations of the WWSS network. Usually data were requested from twenty to forty stations selected to give as good a distribution of data points as possible for each shock. The WWSS data were supplemented by 35 mm microfilm copies of records from the Canadian network, kindly supplied by the Dominion Observatory, and by records of the Saint Louis University network.

Table 1. List of Earthquakes Selected for Study

Date, 63	Time	Lat.	Long.	h	Reg.	Mag.	Geographic Location
Jan. 1	23.39.06	56.6N	157.7W	50	01	6.5	Alaska Peninsula
Jan. 28	13.00.51	54.7N	161.6W	33	01	6.5	Alaska Peninsula
Feb. 5	20.39.22	38.4S	073.2W	41	09	6.5	Coast of Chile
Mar. 7	05.22.01	27.0S	113.5W	33	43	6.7	West of Easter Island
Mar. 10	10.51.48	29.9S	071.2W	70	08	6.3	Coast of Chile
Mar. 16	08.44.48	46.5N	154.7E	26	19	7.7	Kurile Islands
Mar. 26	21.34.41	36.0N	135.7E	33	19	6.5	Honshu, Japan
Mar. 28	00.15.48	66.3N	019.6W	15	40	7.3	Iceland
Mar. 30	16.51.57	44.2N	148.0E	33	19	6.3	Kurile Islands
Apr. 2	16.18.56	53.2N	171.7W	142	01	6.5	Andreanof, Aleutian Is.
Apr. 13	02.20.58	06.2S	076.5W	125	08	7.0	Central Peru
May 10	22.22.42	02.2S	077.6W	33	08	6.7	Ecuador
May 19	01.03.04	46.5S	075.1W	33	09	6.7	Coast of Southern Chile
May 19	21.35.50	23.8N	045.9W	33	32	6.5	North Atlantic Ocean
May 22	13.56.43	48.6N	154.7E	22	19	6.5	Kurile Islands
Jun 24	04.26.38	59.5N	151.7W	52	01	6.7	Cook Inlet
Jun 26	17.42.41	07.1N	082.3W	20	06	6.5	South Coast Panama
Jun 28	21.55.39	46.5N	153.2E	33	19	6.7	Kurile Islands
Aug. 3	10.21.37	07.7N	035.8W	33	32	6.1	Mid-Atlantic Ocean
Aug. 15	17.25.06	13.8S	069.3W	543	08	8.0	Peru-Bolivia Border
Aug. 29	15.30.31	07.1S	081.6W	23	08	6.5	Coast of Peru
Sep. 4	13.32.12	71.4N	073.3W	33	42	6.5	Baffin Island
Sep. 17	05.54.34	10.6S	078.2W	61	08	6.7	Central Peru
Sep. 24	16.30.16	10.6S	078.0W	80	08	7.0	Coast of Peru
Oct. 3	23.24.35	32.2N	131.6E	33	20	6.5	Kyushu, Japan
Oct. 12	11.26.58	44.8N	149.0E	40	19	7.0	Kurile Islands
Oct. 13	05.17.57	44.8N	149.5E	60	19	8.3	Kurile Islands
Oct. 20	00.53.07	44.7N	150.7E	25	19	7.5	Kurile Islands
Nov. 3	03.10.13	03.5S	077.8W	33	08	6.7	Peru-Ecuador
Nov. 9	21.15.30	09.0S	071.5W	600	08	7.0	Western Brazil
Nov. 10	01.00.39	09.2S	071.5W	600	08	6.7	Western Brazil
Nov. 15	21.06.34	44.3N	149.0E	50	19	6.5	Kurile Islands
Nov. 17	00.48.03	07.6N	037.4W	33	32	6.5	North Atlantic Ocean
Nov. 18	14.38.29	29.9N	113.6W	14	04	6.7	Gulf of California
Dec. 3	23.03.42	22.4S	069.3W	18	08	6.3	Northern Chile

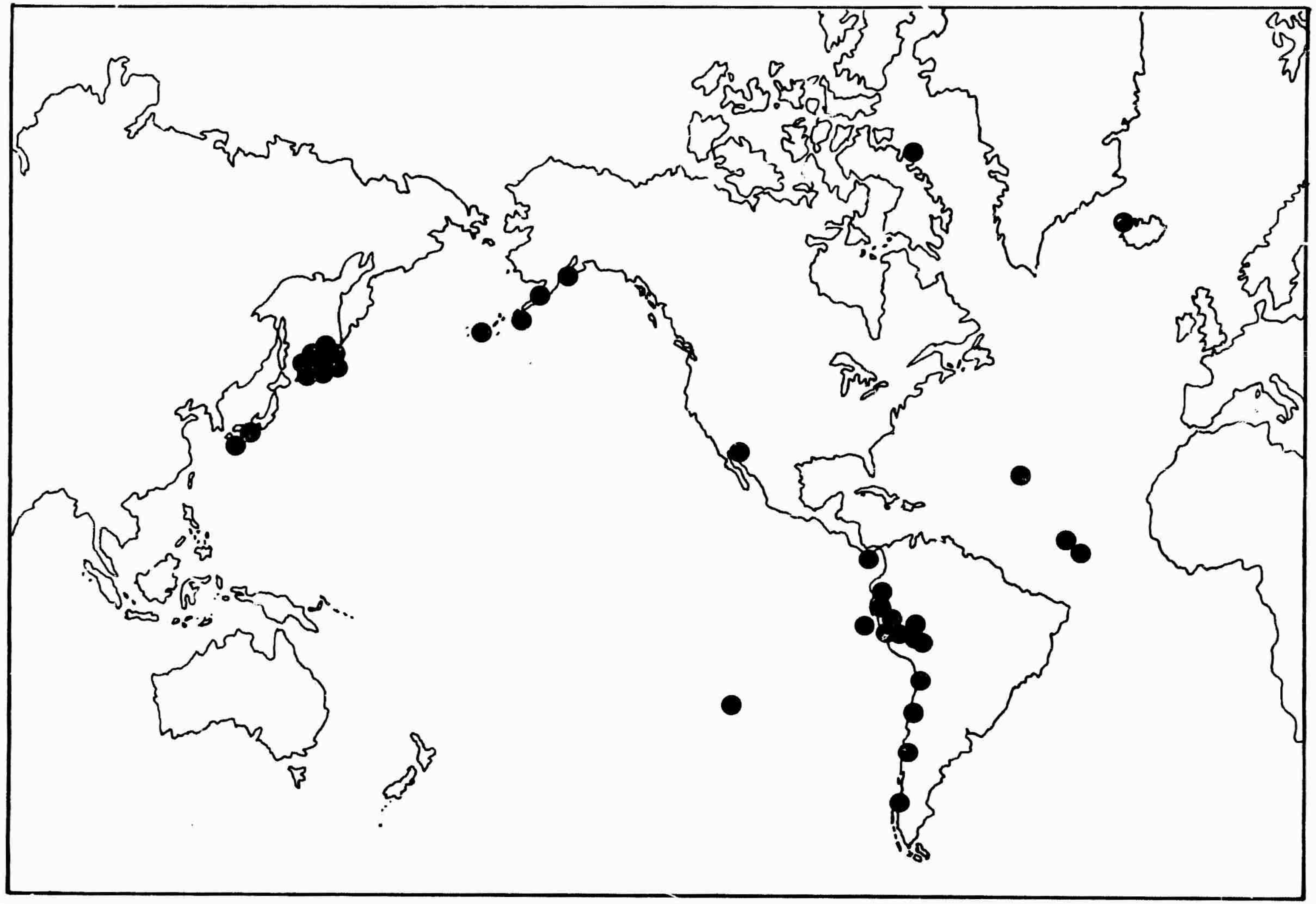


Figure 1. Index map showing the location of the earthquakes of 1963 selected for study. (cf. Table 1).

Table 2. Earthquakes of Magnitude $> 6\frac{1}{4}$, but Less Suitable for S Wave Focal Mechanism Studies

Date, 63	Time	Lat.	Long.	h	Reg.	Mag.	Geographic Location
Jan. 28	12.12.20	02.6S	149.9E	33	16	6.5	New Britain
Jan. 30	10.10.04	55.6S	028.3W	33	10	6.5	Sandwich Islands
Feb. 13	08.50.02	24.5N	121.8E	33	21	7.3	Northern Formosa
Feb. 13	18.13.55	09.9S	160.8E	29	15	6.5	Solomon Is.
Feb. 14	07.04.41	07.2S	128.2E	197	24	6.5	Banda Sea
Feb. 14	22.07.54	05.0S	144.6E	80	16	6.5	Eastern New Guinea
Feb. 26	20.14.09	07.5S	146.2E	171	16	7.5	Eastern New Guinea
Feb. 27	04.30.01	06.0S	149.4E	52	16	6.7	New Britain
Mar. 24	02.07.13	09.7S	120.4E	33	24	6.3	Sumba Is.
Mar. 26	09.48.20	29.7S	177.8W	45	12	7.0	Kermadec Is.
Mar. 26	13.25.03	29.8S	177.9W	42	12	7.3	Kermadec Is.
Mar. 31	05.30.49	29.9S	177.7W	48	12	6.5	Kermadec Is.
Mar. 31	07.07.36	06.1S	149.0E	60	16	6.3	New Britain
Mar. 31	19.22.53	30.0S	178.0W	50	12	6.5	Kermadec Is.
Apr. 16	01.29.19	00.8S	128.0E	33	23	7.0	Halmahera
Apr. 16	01.36.59	01.2S	128.4E	33	23	6.3	Halmahera
Apr. 17	02.11.26	19.6S	178.6E	33	12	6.7	Fiji Islands
Apr. 19	07.35.24	35.8N	096.9E	33	27	7.0	Tsinghai, China
Apr. 30	00.58.18	00.7S	129.0E	33	23	6.7	Halmahera Region
May 1	10.03.20	19.0S	169.0E	140	14	7.0	New Hebrides Islands
May 20	11.38.01	30.7S	178.3W	34	12	7.0	Kermadec Is.
Jun 2	21.04.24	58.5S	015.6W	50	10	6.3	Sandwich Is.
Jun 10	04.16.38	55.4S	146.4E	33	45	6.3	Macquarie Is.
Jun 10	06.39.04	55.3S	146.1E	18	45	6.5	Macquarie Is.
Jul 4	10.58.13	26.3S	177.7W	158	12	7.0	Tonga Islands
Jul 29	20.14.07	30.2S	177.3W	39	12	6.7	Kermadec Is.
Aug. 14	18.43.56	03.4S	135.4E	33	16	6.4	West Irian
Aug. 22	19.52.25	09.4S	150.0E	33	15	7.0	Solomon Is.
Aug. 25	12.18.13	17.5S	178.8W	565	12	6.5	Fiji Islands
Sep. 15	00.46.54	10.3S	165.6E	43	14	7.5	Santa Cruz Is.
Sep. 17	19.20.08	10.1S	165.3E	17	14	7.5	Santa Cruz Is.
Sep. 18	16.58.13	40.9N	029.2E	33	30	6.3	Turkey
Oct. 31	03.17.42	21.8S	175.0W	33	12	6.5	Tonga Is.
Nov. 4	01.14.33	15.1S	167.3E	154	14	7.0	New Hebrides
Dec. 15	19.34.46	04.8S	108.0E	650	24	6.4	Java Sea
Dec. 18	00.30.03	24.8S	176.6W	46	12	6.5	Tonga Islands
Dec. 31	17.37.32	56.5S	026.0W	30	10	6.5	Sandwich Is.

A film reader-digitizer was used to digitize the S wave portion of the records. An IBM 1620 program resolves the raw data into radial and transverse components and prepares a paper-tape output for the plotting of particle motion diagrams by an X-Y plotter. The angle γ, where $\gamma = \tan^{-1}(\overline{SH}/\overline{SV})$, is read from the diagram. $\overline{SH}$ and $\overline{SV}$ are the horizontal components of the S wave motion at the free surface. From this the angle of polarization, $\epsilon = \tan^{1}(SH/SV)$, where SH and SV are the amplitude of the incident wave, is determined from the relation

$$\tan \epsilon = \tan \gamma \cos j_o$$

Here j_o is the angle of incidence of the S wave at the station. For the epicentral distances of concern, j_o is usually less than 33^o and ϵ does not vary significantly from γ. The largest difference between the two angles occurs for the value of $\epsilon = 45^o$, and does not exceed 5^o. This is less than the limit of accuracy in determining from the polarization diagrams.

At epicentral distances less than 44^o, the angle γ is determined where possible by the relations developed by Nuttli (1964). In the listing of the data in Appendix 2, these determinations are identified by the designation "Near" in the column which distinguishes the grade of the individual determinations of the polarization, and in the diagrams of Appendix 1 such data are indicated by the dashed polarization lines.

The S wave data are supplemented by data from the first motion of P. These readings were gathered from station bulletins, according as these were available for relatively recent earthquakes, and from direct readings of the P phase on the WWSS films. The P data are also listed in Appendix 2.

Interpretation

A complete description of the method of interpretation was given in the previous report (Stauder and Bollinger, 1964a). In determining the focal mechanism of each earthquake use was made of an equal projection (Schmidt net) of the lower hemisphere of the focal sphere. Both P and S wave data were plotted and a nodal plane solution was determined by trial and error until a visual best-fit was obtained to the P wave first motion and S wave polarization pattern expected for a theoretical point source model of the focus. As measures of accuracy of the solution the average error, $\delta\bar{\epsilon}$, and the standard deviation, S_ϵ, were computed for the S wave data.

$$\delta\bar{\epsilon} = \frac{\sum_{i=1}^{N} |\epsilon_{oi} - \epsilon_{ci}|}{N}$$

$$S_\epsilon = \sqrt{\frac{\sum_{i=1}^{N} (\epsilon_{oi} - \epsilon_{ci})^2}{N-1}}$$

where

ϵ_{oi} = the observed polarization angle of station i.

ϵ_{ci} = the theoretical polarization angle computed for station i for the source model chosen.

The values of $\delta\varepsilon$ and S_ϵ were also used in selecting between variants of the solution or in altering a trial solution so as to minimize the error in ϵ .

The above method is entirely graphical. In the course of the year a computer program was also devised to automate and to improve the interpretation of the data. The program is basically a search program. First an error surface is computed, determined by the values of S_ϵ corresponding to trial positions of the x axis of the double couple as this x axis is varied methodically over a grid of values so as to cover the lower hemisphere of the focal sphere. The original grid involves 10° increments in φ_x, the trend of the x axis, and 5° increments in θ_x, the angle this axis makes with the downward vertical. Minima on the error surface are selected, and then a series of finer 3 x 3 grids are used to examine the behavior of S_ϵ in the neighborhood of the minima on the larger grid. In this way increments 6.4°, 1.6°, 0.4°, and 0.1° in φ_x, θ_x are used consecutively in searching for the position of the x and y axes for which the value of S_ϵ is minimum.

In finding the error surface a routine similar to that described by Udias (1964) is used. That is, for any trial position (φ_x, θ_x) of the x-axis, any single S wave observation, e.g. at the i-th station, will yield a unique position (φ_{y_i} , θ_{y_i}) of the corresponding y axis. By the orthogonality condition the point at which this axis intersects the focal sphere must lie along the trace of the

plane normal to the x-axis. Positions (φ_{y_i} , θ_{y_i}) so obtained for all N stations for which polarization data are available, will, of course, vary widely, since (φ_x , θ_x) is not the true position of the x axis but is rather arbitrarily chosen at a grid point. All the (φ_{y_i} , θ_{y_i}) will lie along the nodal line. A mean position ($\overline{\varphi}_y$, $\overline{\theta}_y$) is taken, and the corresponding error of the S wave polarization at each station relative to this selection of axis may then be computed by the relation

$$\delta\epsilon_i = (\epsilon_{oi} - \epsilon_{ci}) = \psi_i(\varphi_x, \theta_x, \overline{\varphi}_y, \overline{\theta}_y)$$

where ϵ_{oi} and ϵ_{ci} have the meaning given above. Or, since $\overline{\varphi}_y$ and $\overline{\theta}_y$ may be written as functions of φ_x and θ_x ,

$$\delta\epsilon_i = \psi_i'(\varphi_x, \theta_x)$$

The error surface itself which we have used, is a surface of standard deviation of the polarization angles relative to each grid position of (φ_x, θ_x). That is, at each grid point we may obtain a value

$$S_\epsilon = \left[\sum_{i=1}^{N} \delta\epsilon_i^2 / (N-1) \right]^{1/2}$$

It is the minima on this S_ϵ surface which are then examined in detail.

This search procedure was used in many cases in the interpretation of data for the earthquakes here examined. It obtains the solution which best fits the S wave data in

the sense implied above. The solutions so obtained are, in general, similar to those obtained by the purely graphical procedure, but are better fits to the S wave data than are the graphical solutions. In some cases, however, the search solutions do not agree as well as might be with the P wave data. In these cases adjustments to the nodal planes have been made to obtain a solution which "best fits," to the best estimate of the interpreter, both the P and the S wave data.

IV. Results

The results of all the earthquakes studied are summarized in Table 3. The focal mechanism solution diagrams, represented on an equal area projection of the lower half of the focal sphere, are also presented for each earthquake, together with comments on the solution, in Appendix 1. The P and S wave data are listed in the tables of Appendix 2.

In all, a satisfactory focal mechanism was determined for 26 earthquakes. The parameters of these solutions are indicated in Table 3. The earthquakes are arranged in this table according to the geographic location of the epicenters, beginning from Japan and proceeding clockwise around the borders of the Pacific Ocean.

In the case of six earthquakes the data were not sufficient or were lacking in coherence for a well-determined solution. Yet even in these cases it is felt that long study of the data and an examination of possible solutions

have resulted in at least a possible if not also a probable interpretation of the data. For these earthquakes a tentative solution is advanced. In order to separate clearly focal mechanisms of this character from the better determined solutions, the tentative solutions are not given in Table 3 but only in Appendix 1, where the graphical presentation of the data and of the focal mechanism diagrams are given. These cases are indicated by the words "See Appendix 1" in Table 3.

For three earthquakes no solution was obtained, either because the data were too few or because the P and S wave data were too poor or too inconsistent with one another to forward even a tentative solution. These cases are indicated by the words "No solution" in Table 3.

In any regional studies which incorporate the results here presented, only the more reliable solutions, that is, those whose parameters are given in Table 3, should be used.

The values tabulated are the dip direction, dip, and slip angle for each of the nodal planes of P, and the trend and plunge of the B, P, and T axis. The slip angle is the angle measured in the nodal plane between the horizontal and the direction of motion on the fault if the plane in question be considered the fault plane. The B axis is the null axis or intersection of the nodal planes, the P and T axes are the axes of greatest and least compressive stress, respectively. Planes a and b are designated according to

the nomenclature introduced by Hodgson: if the strike of the nodal planes be given in the range from N90°W to N90°E, plane a is that one of the nodal planes with the more easterly strike and plane b is the other nodal plane.

The last column in Table 3 indicates whether the motion corresponding to plane a as the fault plane is right lateral (R) or left lateral (L), and whether the earthquake motion represents a compressional action (P) or shortening of the earth's crust, or a tensional action (T) or stretching of the crust. If R or L is placed first in this column the motion on plane a would be predominantly strike slip; if R or L is second, the motion is predominantly dip-slip.

The quantities tabulated in Table 3 were measured on a 10 cm Schmidt net. Consequently small errors or departures from orthogonality may occur in the orientations of the nodal planes or axes of the solutions. The accuracy of measurement on the net should normally be of the order of $\pm 1^{\circ}$

All data, both P wave and S wave, on which the solutions are based are given in Appendix 2. The data and the equal area projection of the mechanism solution for each of the earthquakes in Table 1 are presented in Appendix 1. Under each solution diagram are included the average error, $\delta\varepsilon$, and the standard deviation, S_{ε}, of the S wave data, the agreement between the P wave data and the solution in question, and comments on the solution. While both P and S wave data were considered in determining the solutions,

preference is given to the S wave data in this project. Also in the consideration of the P wave data a lesser weight was given to points in immediate proximity to nodal lines.

V. Discussion and Conclusions

As for the earthquakes of 1962, the polarization of S waves has been used successfully in determining focal mechanisms. While in no case have we endeavored to base a solution solely on the data of S waves, the S wave data have made possible in many cases a fully determined fault plane solution where none was possible on the data of P wave first motion alone. This is particularly applicable to situations in which the P wave first motion field is all of one sign, or in which the first motion field clearly indicates separation of one first motion compression field from a rarefaction field, but does not suffice for defining the nodal planes.

In the period 1962-1963 a number of additional stations of the WWSS system became operational. This is reflected in the increased number of data available. For virtually the same number of earthquakes examined (thirty-six for 1962 vs thirty-five for 1963), 532 polarization angles were determined for 1963 vs 399 for 1962, - an increase of 34%. Also 1666 P wave first motions were used, an increase of 551 points or 49% over 1962.

In general, the reliability of the data for the two

years remained virtually unchanged. The average error in the S wave polarization for the 517 polarizations used in the thirty-two solutions and tentative solutions is given by $\delta\varepsilon = 16.2^\circ$ (versus 15.5° for 1962)and $S_\varepsilon = 21.8^\circ$. For the P wave data 12.7% of the points were inconsistent (vs 12.9% for 1962).

As a result of the earthquakes studied both from 1962 and from 1963 we may here remark

1. A definite relationship of the S wave polarization pattern to the mechanism at the focus of an earthquake is born out.
2. In all cases where S wave data and P wave data are of good quality there is agreement between the two kinds of data.
3. In almost all cases (only one exception for 1963) the S wave data may be interpreted as conforming to a double couple point source equivalent of the earthquake focus.
4. The S wave data are particularly advantageous in studying those foci for which the P wave first motion data are predominently of one sign, or for which the P wave data define clearly only two fields of first motion on the lower hemisphere of the focal sphere, one rarefactional, the other compressional. In these cases one nodal plane is steeply dipping, the other is nearly horizontal and cannot be determined from the first motion data alone.

The earthquakes of three regions for 1963 merit special attention.

1. A series of earthquakes, including shocks both preceding and following the major earthquake of October 13, 1963, occurred in the Kurile Islands. These earthquakes are similar in character. In several of these shocks one nodal plane of P is determined by the P wave first motion. This plane strikes parallel to the trend of the Kurile Islands. The principal stress systems corresponding to the nodal plane solutions for these earthquakes are similar to those found to be characteristic of the Kurile Islands in previous studies (Stauder and Bollinger, 1964b, Udias and Stauder, 1962).
2. Two deep focus earthquakes, with nearly the same hypocenter occurred in Brazil on November 9 and November 10, about three hours apart. The first of magnitude 7 (or greater) recorded too strongly for optimum conditions of S wave analysis, but both the P and the S wave radiation pattern for the two shocks are very similar.
3. Three earthquakes (May 19, August 3, November 17) occurred along the mid-Atlantic ridge. One of these, that of November 17, is especially well documented in both P and S wave data. The S wave polarization angles for this shock (see the

mechanism diagram under date of November 17 in Appendix 1), is convincing evidence of a double couple source. The mechanisms of the three shocks are similar, and in all three cases the tension axis is nearly horizontal and normal to the local trend of the mid-oceanic ridge.

Table 3. Focal Mechanism Solutions for Earthquakes of 1963

Date 1963	Hr	Lat	Long	h	Plane a			Plane b			B		P		T		
					Dip Direc	Dip	Slip Angle	Dip Direc	Dip	Slip Angle	Trend	Plunge	Trend	Plunge	Trend	Plunge	Plane a
Oct 3	23	32.2N	131.6E	33				See Appendix 1									
Mar 26	21	36.0N	135.7E	33				See Appendix 1									
Mar 30	16	44.2N	148.0E	33	132°	61°	75°	282°	33°	66°	215°	12°	121°	14°	344°	71°	PR
Nov 15	21	44.3N	149.0E	50	188°	14°	83°	1°	76°	88°	271°	2°	180°	59°	3°	31°	TL
Oct 20	00	44.7N	150.7E	25	131°	88°	84°	10°	6°	26°	42°	7°	137°	42°	305°	48°	PL
		Single Couple			43°	90°	51°	223°	40°	0°	223°	40°	101°	33°	345°	33°	L
Oct 12	11	44.8N	149.0E	40	312°	16°	79°	122°	75°	87°	330°	2°	124°	30°	298°	60°	PR
Oct 13	05	44.8N	149.5E	60	357°	30°	50°	133°	68°	69°	51°	20°	148°	20°	283°	62°	PR
Jun 28	21	46.5N	153.2E	33	342°	16°	47°	118°	78°	79°	36°	10°	128°	32°	282°	56°	PR
Mar 16	08	46.5N	154.7E	26	106°	55°	90°	286°	35°	90°	17°	0°	106°	10°	286°	81°	P
May 22	13	48.6N	154.7E	22	310°	60°	55°	185°	45°	46°	240°	30°	334°	9°	79°	59°	PL
Apr 2	16	53.2N	171.7W	142	93°	45°	53°	227°	55°	59°	155°	25°	349°	65°	252°	13°	TL
Jan 28	13	54.7N	161.6W	33	180°	83°	16°	87°	75°	9°	119°	74°	223°	5°	314°	16°	LP
		Alternate			140°	88°	86°	256°	5°	28°	230°	5°	136°	43°	325°	47°	PR
Jan 1	23	56.6N	157.7W	50	96.5°	73°	79°	240°	20.5°	56°	183°	11°	88°	25°	291°	61°	PR
Jun 24	04	59.5N	151.7W	52				See Appendix 1									
Nov 18	14	29.9N	113.6W	14				No Solution									
Jun 26	17	7.1N	82.3W	20	92°	83°	4°	183°	87°	4°	125°	83°	228°	1°	318°	6°	RP
May 10	22	2.2S	77.6W	33				No Solution									
Nov 3	03	3.5S	77.8W	33				See Appendix 1									
Apr 13	02	6.2S	76.5W	125	110°	31°	65°	259°	62.5°	76°	177°	13°	49°	69°	271°	16°	TL
Aug 29	15	7.1S	81.6W	23	275°	44°	67°	68°	59°	76°	345°	12°	212°	72°	79°	13°	TL
Nov 9	21	9.0S	71.5W	600	43.5°	26°	65°	193.3°	67°	79°	109°	11°	353°	66°	203°	21°	TL
Nov 10	01	9.2S	71.5W	600	57°	30°	74°	217°	61°	80°	133°	8°	13°	72°	224°	16°	TL
Sep 24	16	10.6S	78.0W	80	165°	55°	12°	263°	80°	36°	186°	53°	299°	16°	39°	32°	RP
		Alternate			270°	78°	12°	3°	78°	12°	318°	72°	137°	18°	47°	0°	LT
Sep 17	05	10.6S	78.2W	61	155°	58°	72°	5°	36°	64°	76°	14°	296°	72°	168°	12°	TR
		Alternate			54°	52°	82°	223°	39°	81°	140°	6°	272°	82°	49°	5°	TL
Aug 15	17	13.8S	69.3W	543	302°	30°	25°	189°	77°	62°	274°	26°	41°	60°	169°	27°	RT
		Alternate			274°	65.5°	59°	39°	38°	41°	351°	28°	137°	58°	253°	14°	LT
Dec 3	23	22.4S	69.3W	18				No Solution									
Mar 1	10	29.9S	71.2W	70	240°	3°	80°	60°	87°	89°	330°	1°	239°	48°	60°	41°	TR
Feb 5	20	38.4S	73.2W	41	0°	14°	19°	250°	85°	76°	239°	15°	237°	38°	86°	48°	
May 19	01	46.5S	75.1W	33				See Appendix 1									
Mar 7	05	27.0S	113.5W	33	109°	90°	0°	20°	90°	0°		90°	334°	0°	64°	0°	L
Sep 4	13	71.4N	73.3W	33				See Appendix 1									
Mar 28	00	66.3N	19.6W	15	107°	70°	13°	13°	77°	21°	73°	66°	321°	5°	239°	24°	LP
May 19	21	23.8N	45.9W	33	99°	80°	15°	191°	76°	12°	151°	72°	327°	19°	56°	2°	LT
Aug 3	10	7.7N	35.8W	33	282°	86°	11°	191°	80°	4°	222°	78°	325°	5°	57°	12°	LP
Nov 17	00	7.6N	37.4W	33	357°	78°	8°	89°	81°	12°	37°	76°	133°	3°	223°	13°	RP

APPENDIX 1

Graphical Presentation of the P and S Wave Data and the Focal Mechanism Diagrams

The pages which follow are a graphical presentation of the P and S wave data for all thirty-five of the earthquakes of 1963 listed in Table 1. The figures present the focal mechanism diagrams, both for the focal mechanism solutions tabulated in Table 3, and for the tentative solutions not given in Table 3. The projection is an equal area projection of the lower hemisphere of the focal sphere.

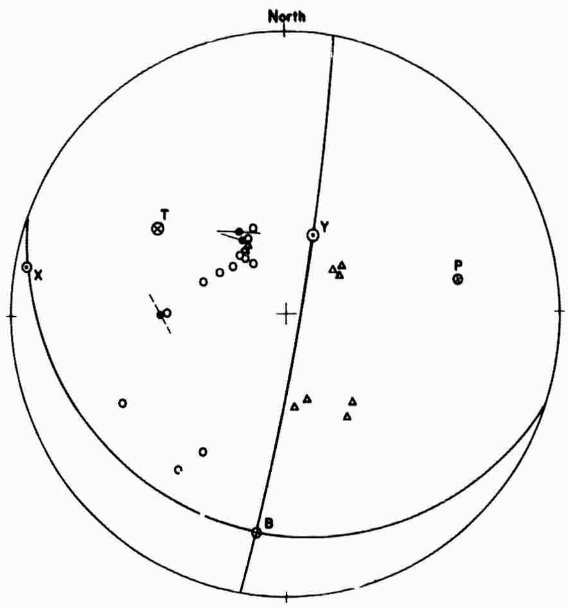
The order of presentation of the solutions is the same as that given in Table 3, that is, in successive order of the epicenters beginning with the western boundary of the Pacific Ocean. The page presenting the solution for an earthquake of a particular date may be inferred by a comparison of the chronological order of Table 1 and the geographic order of Table 3.

S WAVE PROJECT

KYUSHU, JAPAN

OCT.3, 1963 32.2N 131.6E

23-24-35 h=33km. M=6.5



LEGEND

P WAVE DATA
- o Compression
- Δ Dilatation

S WAVE DATA
- Good
- Doubtful
- Near (i > ic)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

TENTATIVE MECHANISM SOLUTION

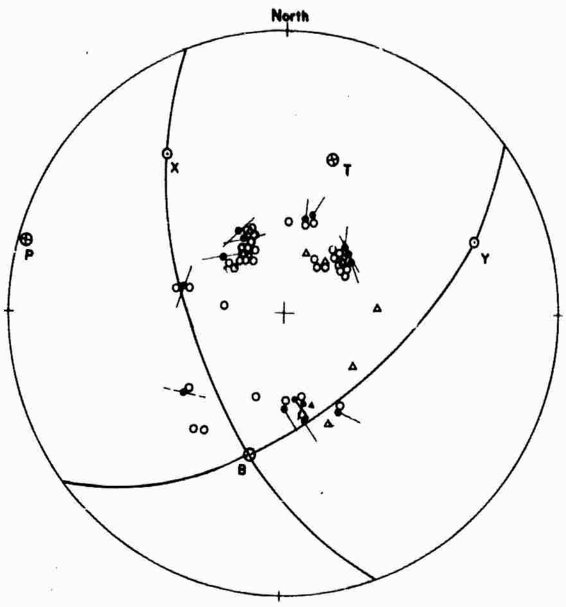
AXIS	AZ	PLUNGE
P	79	36
T	303	44
B	188	23
X	284	4
Y	24	66

Comment: Tentative Solution

S wave data: N = 3; $\delta\bar{\varepsilon} = 17.4^\circ$, $s_\varepsilon = 24.7^\circ$

P wave data: 1 inconsistent of 23.

This solution is presented as tentative since the number of P and S wave observations are insufficient for a well determined solution. In spite of the small number of P wave data, an evident field of compression and rarefaction first motions indicates within limits the position of one of the nodal planes of P. The other is defined only on the basis of the three S wave polarizations.



S WAVE PROJECT

HONSHU, JAPAN

MAR. 26, 1963 36N 135.7E

21-34-41 h=33km. M=6.5

LEGEND

P WAVE DATA
o Compression
▵ Dilatation

S WAVE DATA
Good
Doubtful
Near ($i > i_c$)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

TENTATIVE
MECHANISM SOLUTION

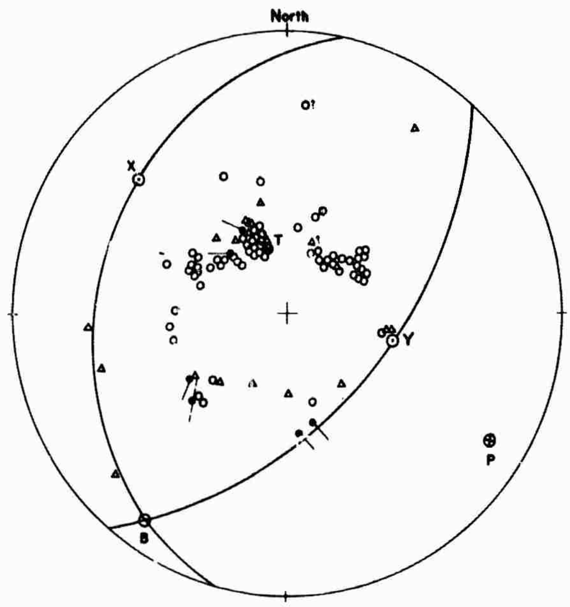
AXIS	AZ	PLUNGE
P	285	3
T	18°	42
B	193	47
X	323	30
Y	69	26

Comment: Tentative Solution

S wave data: N = 15 ; $\delta\bar{\epsilon} = 18.8^{\circ}$, $S_{\epsilon} = 24.5^{\circ}$

P wave data: 13 inconsistent of 50

Tentative solution only. The solution shown is based primarily on the S wave data. The central P wave first-motion field is evidently compressional. Relatively minor adjustment of the nodal planes, including a counterclockwise rotation through about 20°, would improve the P wave score to 6 inconsistent of 50. The P wave and S wave data are in disagreement by about this degree; neither are of exceptional quality.



S WAVE PROJECT

KURILE ISLANDS

MAR. 30, 1963 44.2N 148.E

16-51-57 h=33km. M=6.25

LEGEND

P WAVE DATA
○ Compression
△ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	121	14
T	344	71
B	215	12
X	312	29
Y	102	57

Comment:

S wave data: N = 6 ; $\delta\bar{\varepsilon} = 5.1^\circ$, $S_\varepsilon = 6.2^\circ$

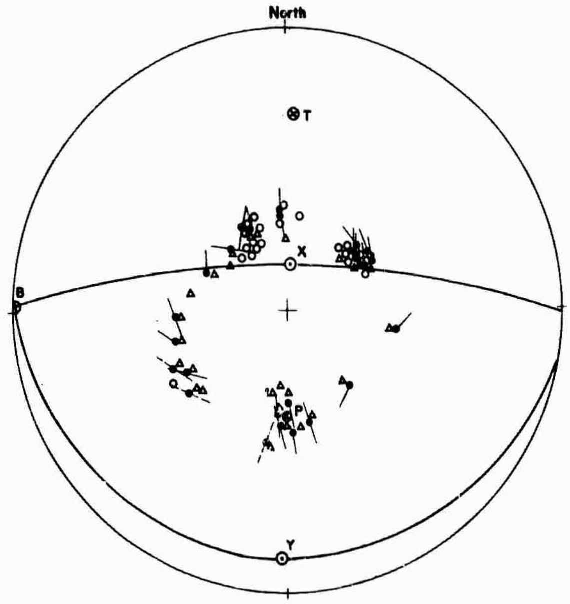
P wave data: 19 inconsistent of 90

This solution is satisfactorily determined. While the number of inconsistent P wave first motion observations is large, half of these occur at stations surrounded by several other stations of opposite polarity. Minor adjustment to the nodal planes would yield about a 5% improvement in the P wave score at the expense of the S wave polarization.

S WAVE PROJECT

KURILE ISLANDS

NOV. 15, 1963 44.3N 149E
21-06-34 h=50km. M=6.5



LEGEND

P WAVE DATA
○ Compression
△ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

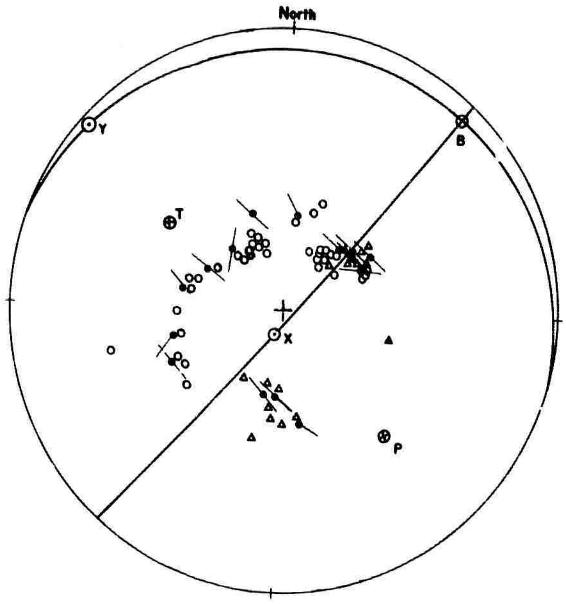
AXIS	AZ	PLUNGE
P	180	59
T	3	31
B	271	2
X	8	76
Y	181	14

Comment:

S wave data: N = 26 ; $\bar{\delta\varepsilon} = 23.8^{\circ}$, $S_{\varepsilon} = 32.0^{\circ}$

P wave data: 8 inconsistent of 50

One nodal plane is well determined on the basis of the P wave data. The second is satisfactorily determined by the S wave data. While the average error and standard deviation of the polarization data are somewhat high, a large error at one station (IST) plus large errors in the vicinity of the P axis, where large errors may easily occur without great significance contribute significantly to these large values.



S WAVE PROJECT

KURILE ISLANDS
OCT. 20, 1963 44.7N 150.7E
00-53-07 h=25km. M=7.5

LEGEND

P WAVE DATA
○ Compression
△ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P,T, & B Axes ⊙ Nodal Plane Poles

DOUBLE COUPLE MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	137°	42°
T	305°	48°
B	42°	7°
X	190°	84°
Y	311°	2°

Comment: Double couple solution (for single couple solution see next page)

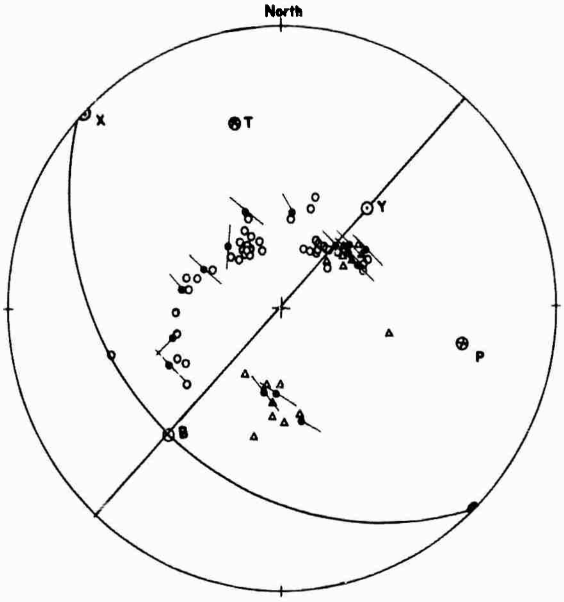
S wave data: N = 15 ; $\overline{\delta\epsilon}$ = 22.6°, S_ϵ = 33.6°

P wave data: 5 inconsistent of 61

This earthquake may be explained either as a double couple source or as a single couple source. For either mechanism one nodal plane, identical in either case, is well determined. The remaining nodal plane is satisfactorily determined, depending on which type of focus is preferred. All inconsistent P wave first motions are clustered in one region of the first quadrant and are in close proximity to the nodal line. See also the single couple solution on the next page.

S WAVE PROJECT

KURILE ISLANDS
OCT. 20, 1963 44.7N 150E
00-53-07 h=25km. M=7.5



LEGEND

P WAVE DATA
○ Compression
△ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

SINGLE MECHANISM COUPLE SOLUTION

AXIS	AZ	PLUNGE
P	101	33
T	345	33
B	223	40
X	314	0
Y	43	50

Comment: Single couple solution (for double couple solution see preceding page)

S wave data: N = 15 ; $\delta\bar{\epsilon} = 18.2^{\circ}$, $S_{\epsilon} = 30.0^{\circ}$

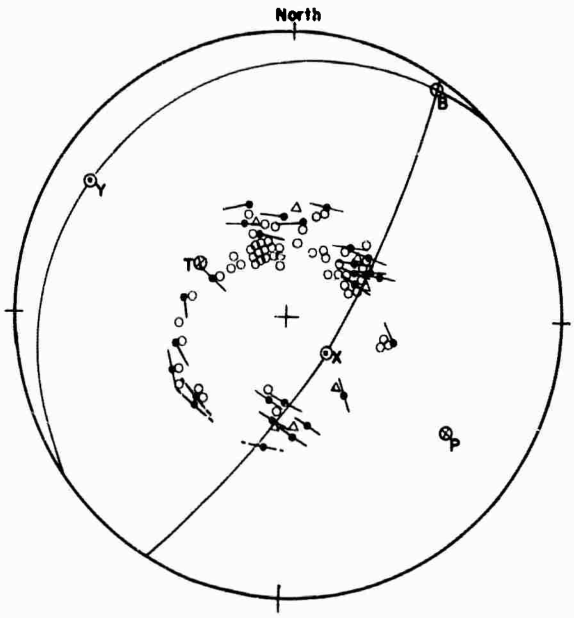
P wave data: 6 inconsistent of 61

This earthquake may be explained either as a double couple source or as a single couple source. For either mechanism one nodal plane, identical in either case, is well determined. The remaining nodal plane is satisfactorily determined, depending on which type of focus is preferred. All inconsistent P wave first motions are clustered in one region of the first quadrant and are in close proximity to the nodal line. See also the double couple solution on the preceding page.

S WAVE PROJECT

KURILE ISLANDS

OCT.12,1963 44.8N 149.0E
11-26-58 h=40km. M=7



LEGEND

P WAVE DATA
o Compression
Δ Dilatation

S WAVE DATA
Good
Doubtful
Near (I> Ic)

⊗ P, T, & B Axes
⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	124	30
T	298	60
B	330	2
X	132	74
Y	302	15

Comment:

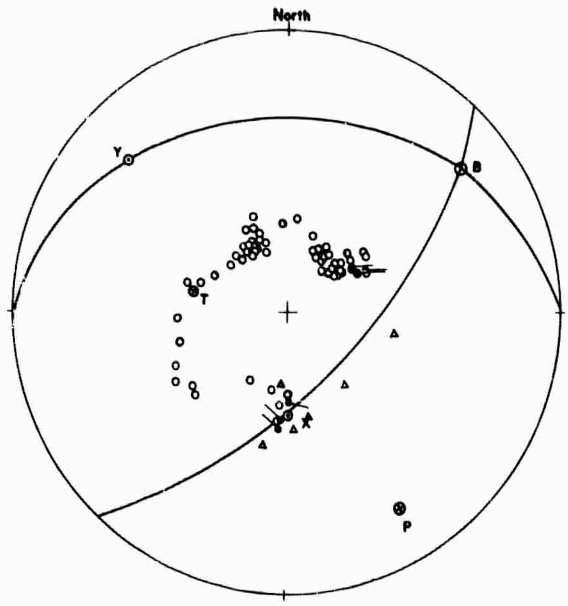
S wave data: N = 27 ; $\delta\bar{\epsilon} = 14.8^{\circ}$, $S_{\epsilon} = 19.5^{\circ}$

P wave data: 7 inconsistent of 62.

This solution is exceptionally well determined. Both the P and the S wave data are of good quality and are in excellent agreement.

S WAVE PROJECT

KURILE ISLANDS
OCT. 13, 1963 44.8N 149E
05-17-57 h=60km. M=8.3



LEGEND

P WAVE DATA
o Compression
△ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P, T, & B Axes
⊙ Nodal Plane Poles

MECHANISM SOLUTION

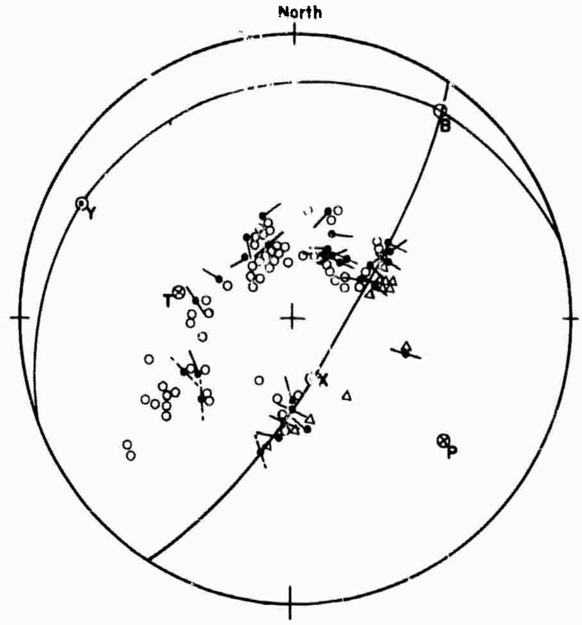
AXIS	AZ	PLUNGE
P	148	20
T	283	62
B	51	20
X	177	60
Y	313	22

Comment:

S wave data: N = 6 ; $\delta\bar{\varepsilon} = 20.0^\circ$, $S_\epsilon = 25.4^\circ$

P wave data: 1 inconsistent of 71

This solution represents the source mechanism of the major earthquake (M = 8.3) of the Kurile Islands earthquake sequence which began on October 13, 1963. The solution presented is in excellent agreement with the P wave data and in satisfactory agreement with the S wave data. While the variance of the polarization angles is relatively large this may be attributed to the fact that the polarizations themselves are difficult to determine because of the magnitude of the shock. Some small variation in the orientation of the nodal planes may be allowed, but a definitive solution satisfying the P and S wave data cannot differ significantly from the solution shown.



S WAVE PROJECT

KURILE ISLANDS

JUNE 28, 1963 46.5N-153.2E
21-55-39 h=33 km. M=6.75

LEGEND

P WAVE DATA
o Compression
Δ Dilatation

S WAVE DATA
Good
Doubtful
Near (I > Ic)

⊗ P, T, & B Axes
⊙ Nodal Plane Poles

MECHANISM SOLUTION

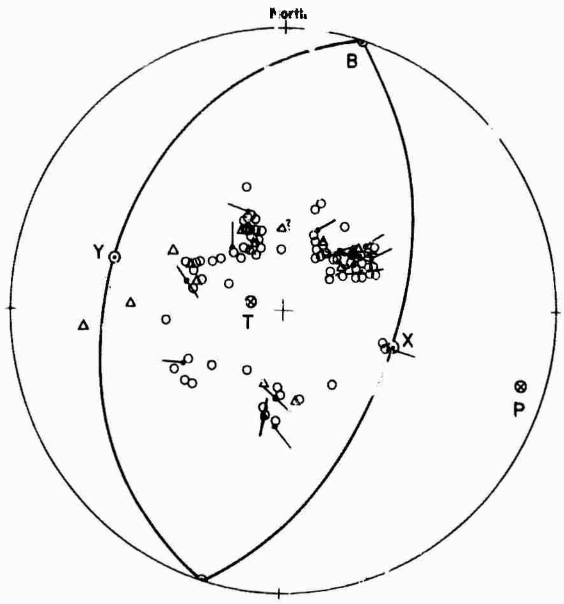
AXIS	AZ	PLUNGE
P	128	32
T	282	56
B	36	10
X	162	74
Y	298	12

Comment:

S wave data: N = 31 ; $\bar{\delta\varepsilon}$ = 20.2°, S_ε = 27.7°

P wave data: 1 inconsistent of 73

One nodal plane of P is exceptionally well determined by the P wave data, and in agreement with the S wave data. The second nodal plane is satisfactorily determined by the S wave polarization. This is a good solution.



S WAVE PROJECT

KURILE ISLANDS

MAR.16,1963 46.5N 154.7E

08-44-48 h=26km. M=7.75

LEGEND

P WAVE DATA
o Compression
Δ Dilatation

S WAVE DATA
Good
Doubtful
Near (i>ic)

⊗ P,T,& B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	106	10
T	286	81
B	17	0
X	106	55
Y	286	35

Comment:

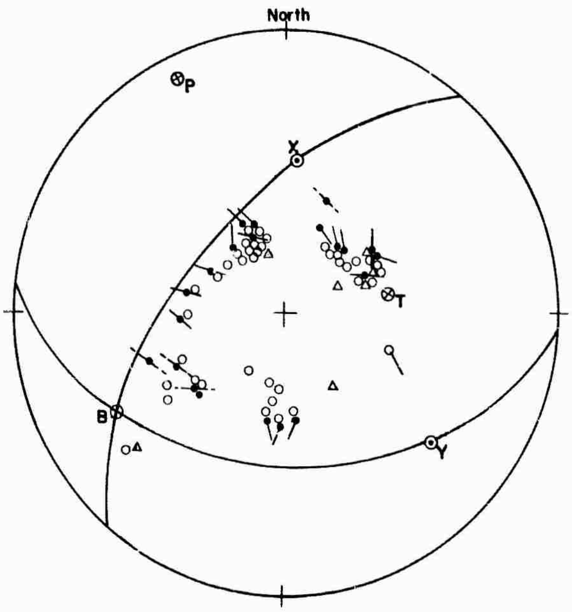
S wave data: N = 17 ; $\delta\bar{\varepsilon}$ = 16.9°, s_{ε} = 22.8°

P wave data: 15 inconsistent of 97

A fair solution. Inconsistent P first motion data are rarefactions distributed randomly among data points of the opposite polarity. There is no doubt that the central field is compressional, corresponding to a steeply plunging T axis. The orientation of the nodal planes is moderately well determined by the S wave polarization.

S WAVE PROJECT

KURILE ISLANDS
MAY 22, 1963 48.6N 154.7E
13-56-43 h=22 km. M=6.5



LEGEND

P WAVE DATA
o Compression
△ Dilatation

S WAVE DATA
Good
Doubtful
Near (I > Ic)

⊗ P, T, & B Axes
⊙ Nodal Plane Poles

MECHANISM SOLUTION

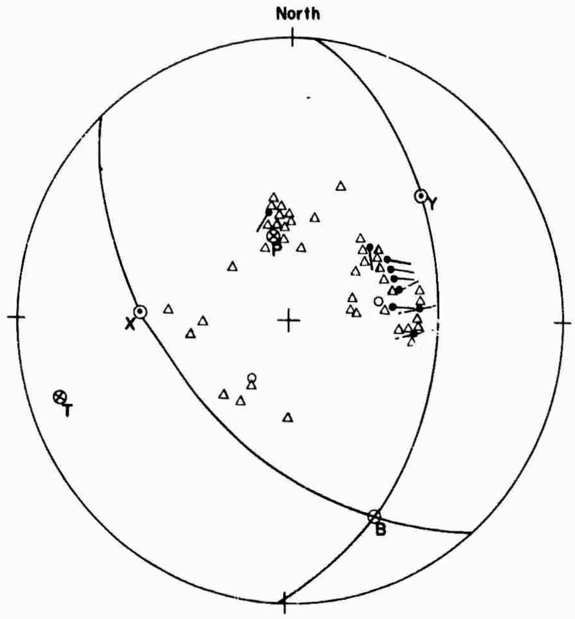
AXIS	AZ	PLUNGE
P	334	9
T	79	59
B	240	30
X	5	45
Y	130	30

Comment:

S wave data: N = 23 ; $\delta\bar{\epsilon} = 22.0^{o}$, $S_{\epsilon} = 29.4^{o}$

P wave data: 8 inconsistent of 52

This is a fair solution. As in the solution on the preceding page, the central field is compressional and the nodal planes are moderately well determined by the S wave data.



S WAVE PROJECT

ALEUTIAN ISLANDS
APR. 2, 1963 53.2N 171.7W
16-18-56 h = 142 km. M = 6.5

LEGEND

P WAVE DATA
o Compression
△ Dilatation

S WAVE DATA
—•— Good
•— Doubtful
--•-- Near (I > Ic)

⊗ P, T, & B Axes
⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	349	65
T	252	13
B	155	25
X	273	45
Y	47	35

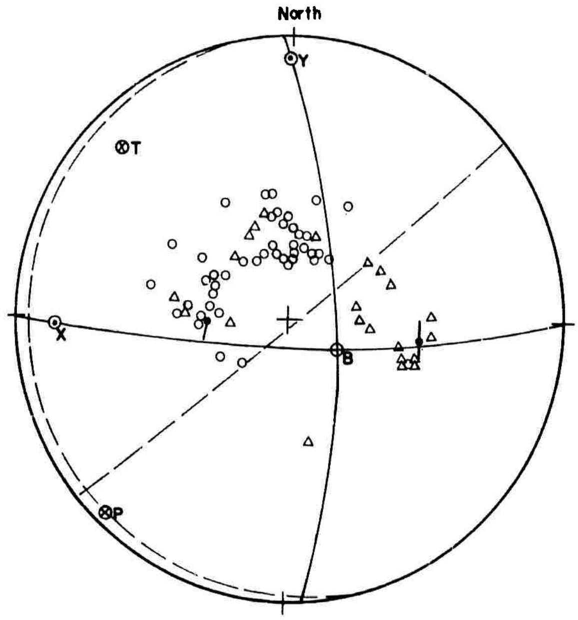
Comment:

S wave data: N = 9 ; $\overline{\delta\epsilon} = 11.6^{\circ}$ (20.2°), $S_{\epsilon} = 14.4^{\circ}$ (34.1°)

P wave data: 2 inconsistent of 48

The central field in this case consists, without doubt, of rarefaction first motions. No solution is possible on the basis of P wave data alone, though limits can be placed on the dip of the nodal planes; dips of these planes cannot exceed about 55°. The distribution and quality of the S wave data are not too good, but suffice for a moderately satisfactory solution. That is, the polarization data at stations in the United States require that one nodal plane strike in a general north-south direction; this factor, plus the P wave first motion and restraints of the model fix the second nodal plane. One S wave polarization at OGD (included in the diagram above) was excluded in computing the

average error and standard deviation of the polarization angles since the error in the polarization at this station is large and the polarization is clearly not in agreement with that at several nearby stations. Including OGD we have $\delta\bar{\epsilon} = 20.2^\circ$, $s_\epsilon = 14.4^\circ$.



S WAVE PROJECT

ALASKA PENINSULA

JAN.28,1963 54.7N 161.6W

13-00-51 h=33 km. M=6.5

LEGEND

P WAVE DATA
o Compression
Δ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P,T, & B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	223	5
T	314	16
B	119	74
X	267	15
Y	360	7

Comment: (Alternate solution tabulated below)

S wave data: N = 2; $\bar{\delta\varepsilon}$ = 9.1°, S_ε = 14.9°

P wave data: 15 inconsistent of 72

This solution is selected to minimize the errors in the polarization angles. In this case certainly too much weight is given to the few (2 only!) S wave data points and not sufficient weight to the P wave data. A clockwise rotation of the solution through less than 15°, with an adjustment of 2°-3° in the dips of the nodal planes would improve the P wave score to 9 inconsistent of 72.

An alternate solution may also be proposed, with trend and plunge of axes as follows:

P	T	B	X	Y
136°, 43°	325°, 47°	230°, 05°	320°, 02°	176°, 85°

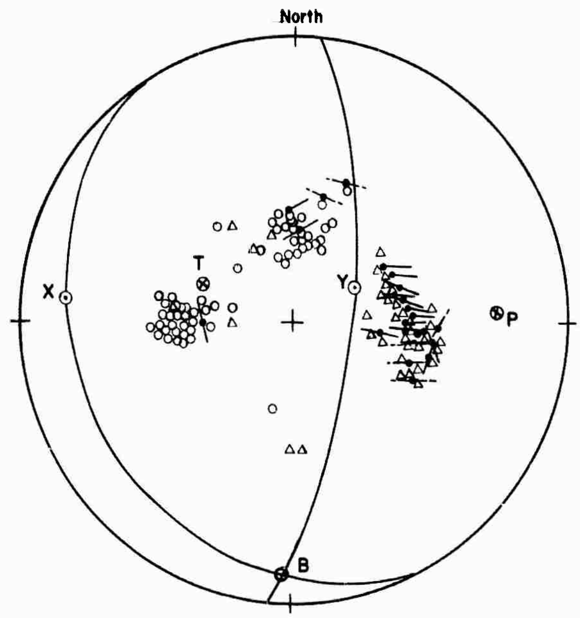
This alternate solution is indicated by the dashed lines on the figure. For this solution $\delta_{\epsilon} = 24.3^{\circ}$, $S_{\epsilon} = 35.2^{\circ}$, and 9 P data points are inconsistent. The S wave data are obviously poorly satisfied, but the solution offers a limit to the variation possible on the basis of the P data.

S WAVE PROJECT

ALASKA PENINSULA

JAN. 1, 1963 56.6N 157.7W

23-39-06 =50 M=6.5



LEGEND

P WAVE DATA	S WAVE DATA
○ Compression	Good
△ Dilatation	Doubtful
	Near (I > ic)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	88	25
T	291	61
B	183	11
X	276.5	17
Y	60	69.5

Comment:

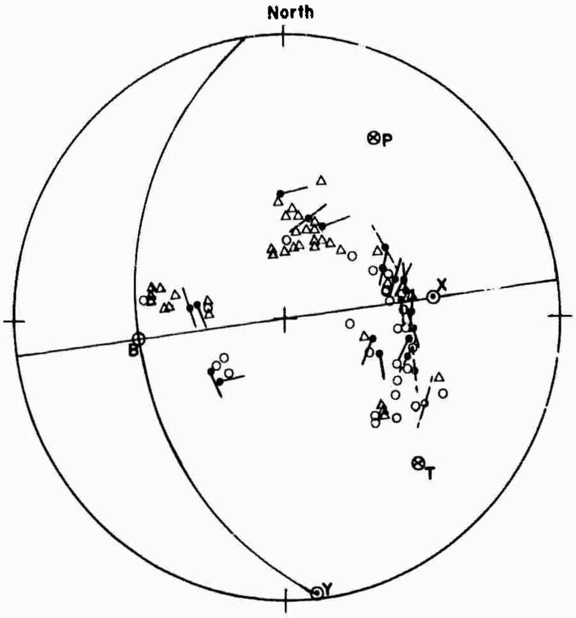
S wave data: N = 23 ; $\delta\bar{\varepsilon} = 12.8^{\circ}$, $s_{\varepsilon} = 21.0^{\circ}$

P wave data: 7 inconsistent of 108

This solution is well determined on the basis of both the P and the S wave data. Some variation, about 15°-20° in the strike of the plane designated by the X axis as normal, is possible thereby making consistent two more P data points but at the expense of the error in the polarization angles. Thus if we alter the axes as follows

P	T	B	X	Y
88°, 31°	316°, 49°	193°, 24°	288°, 10°	39°, 63°

we have that $\delta\bar{\varepsilon} = 16.6^{\circ}$ and $s_{\varepsilon} = 23.7^{\circ}$.



S WAVE PROJECT

COOK INLET, ALASKA
JUNE 24,1963 59.5N 151.7W
04-26-38 h=52 km. M=6.75

LEGEND

P WAVE DATA
o Compression
▲ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

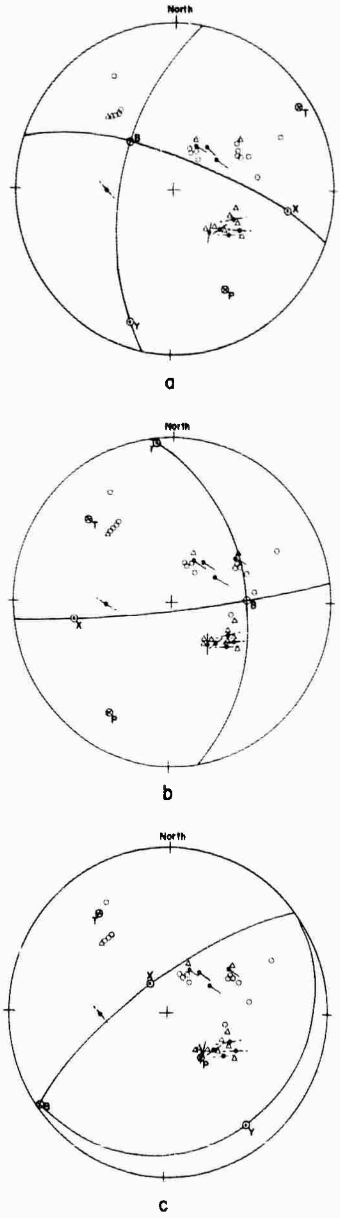
AXIS	AZ	PLUNGE
P	27	30
T	137	30
B	262	45
X	82	45
Y	172	0

Comment: Tentative Solution

S wave data: N = 21 ; $\delta\varepsilon = 25.6^{\circ}$, $S_{\varepsilon} = 32.2^{\circ}$

P wave data: 14 inconsistent of 64

The solution shown gives the best fit to both the P and the S wave data, but the quality of the data is such that no well defined solution is possible taking the P and S wave data either singly or in combination. The nodal plane here given as vertical is certainly defined, $\pm 10^{\circ}$, from the extreme position shown to a second extreme position obtained by rotating counterclockwise through 20°, but the P wave score is thereby only improved to 11 inconsistent of 64.



S WAVE PROJECT

GULF OF CALIFORNIA

NOV. 18, 1963 29.9N 113.6W

14-38-29 h=14 km. M=6.75

LEGEND

P WAVE DATA		S WAVE DATA	
o	Compression	Good	
Δ	Dilatation	Doubtful	
		Near (i > ic)	

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

Comment: No solution is proposed.

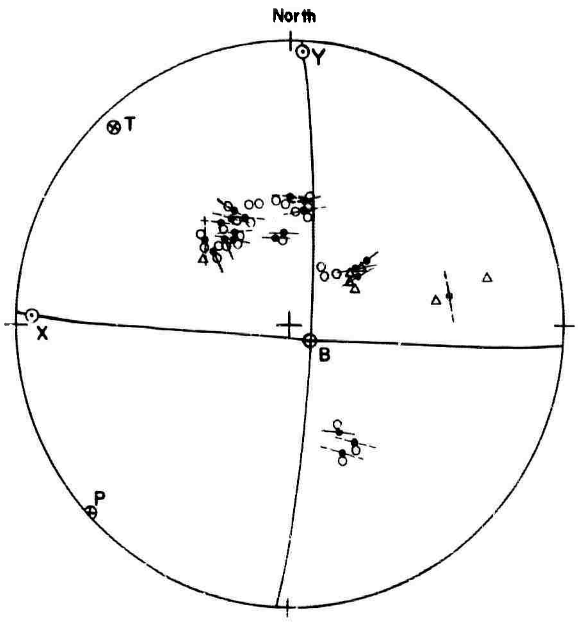
Several solutions were attempted, but no satisfactory solution could be obtained. For example

<u>Solution a</u> is a single couple solution, which gives for the S wave data (N = 10) $\overline{\delta\epsilon}$ = 22.30, S_ϵ = 32.2°, and for the P wave data 6 inconsistent of 27. The P wave score could easily be improved to 3 inconsistent of 27. This represents the "best" solution.

Solution b is a double couple solution which best fits both the P and the S wave data. S wave data: $\delta\bar{\epsilon} = 24.5^{\circ}$, $S_{\epsilon} = 30.2^{\circ}$; P wave data: 6 inconsistent of 27.

Solution c is a double couple solution which best fits the S wave data, neglecting the P wave data. S wave data: $\delta\bar{\epsilon} = 16.7^{\circ}$, $S_{\epsilon} = 24.2^{\circ}$; P wave data: 13 inconsistent of 27.

A San Andreas type solution was also attempted (plane a: strike N 46°E, dip 85° SE: plane b: strike N48°, dip 55°NE). For this solution there are 5 P wave points inconsistent of 27. The solution does not fit the S wave at all ($\delta\bar{\epsilon} = 39.4^{\circ}$, $S_{\epsilon} = 49.8^{\circ}$).



S WAVE PROJECT

SO. COAST OF PANAMA

JUNE 26, 1963 7.1N 82.3W

17-42-41 h=20km. M=6.5

LEGEND

P WAVE DATA
- ○ Compression
- △ Dilatation

S WAVE DATA
- Good
- Doubtful
- Near (i>ic)

⊗ P,T,&B Axes

⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	228	1
T	318	6
B	125	83
X	272	7
Y	3	3

Comment:

S wave data: N = 21 ; $\overline{\delta\varepsilon}$ = 15.3°, S_ε = 18.6°

P wave data: 4 inconsistent of 35

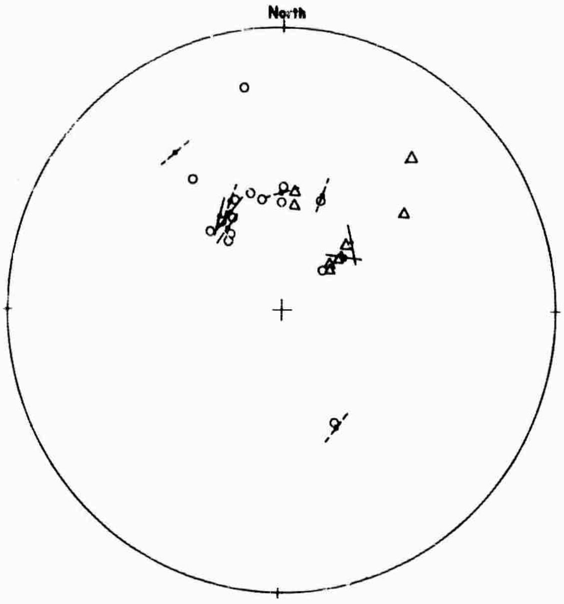
This solution is satisfactorily determined as fitting best both the P and the S wave data.

S WAVE PROJECT

ECUADOR

MAY 10, 1963 2.2S 77.6W

22-22-42 h=33km. M=6.75



LEGEND

P WAVE DATA
- o Compression
- Δ Dilatation

S WAVE DATA
- Good
- Doubtful
- Near (i > i_c)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

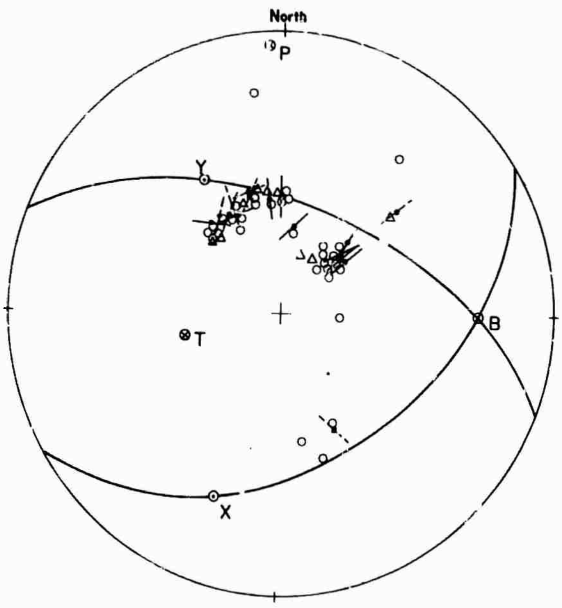
AXIS	AZ	PLUNGE
P		
T		
B		
X		
Y		

Comment: No solution

Taken separately neither the P nor the S wave data are sufficient to permit of a determined solution. Taken together the two kinds of data are not in agreement with one another. For example, the solution shown in the diagram was attempted

P	T	B	X	Y
171°, 15°	268°, 23°	47°, 63°	218°, 28°	311°, 7°

but $\delta\bar{\epsilon} = 22.2^\circ$ and $S_{\epsilon} = 26.4^\circ$; there are 9 inconsistent P wave first motions of 26.



S WAVE PROJECT

PERU-ECUADOR

NOV. 3, 1963   3.5S 77.8W

03-10-13   h=33km. M=6.75

LEGEND

P WAVE DATA
Compression
Dilatation

S WAVE DATA
Good
Doubtful
Near (I > Ic)

P, T, & B Axe   Nodal Plane Poles

TENTATIVE
MECHANISM SOLUTION

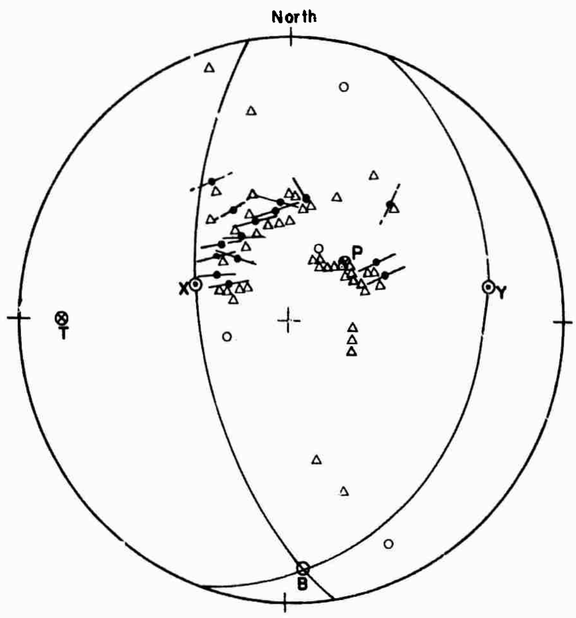
AXIS	AZ	PLUNGE
P	357	6
T	257	60
B	90	28
X	200	32
Y	328	44

Comment: Tentative Solution

S wave data: N = 18 ; $\delta\bar{\varepsilon} = 24.5^{\circ}$, $S_{\varepsilon} = 32.7^{\circ}$

P wave data: 9 inconsistent of 45.

This solution is presented as tentative, since neither the P wave data nor the S wave data are of good quality.



S WAVE PROJECT

CENTRAL PERU

APR. 13, 1963 6.2S 76.5W

02-20-58 h=125 km. M=7

LEGEND

P WAVE DATA
- o Compression
- ▲ Dilatation

S WAVE DATA
- Good
- Doubtful
- Near (I > Ic)

⊗ P, T, & B Axes   ⊙ Nodal Plane Poles

MECHANISM SOLUTION

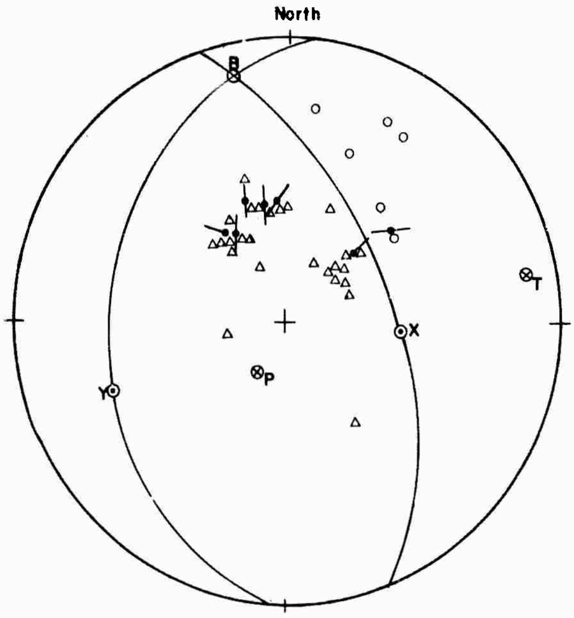
AXIS	AZ	PLUNGE
P	49	69
T	271	15
B	177	13
X	290	59
Y	79	27.5

Comment:

S wave data: N = 15 ; $\delta\bar{\varepsilon} = 12.8^{\circ}$, $S_{\epsilon} = 17.3^{\circ}$

P wave data: 4 inconsistent of 50

This solution is satisfactorily determined on the basis of both the P and the S wave data. The central first motion field consists of rarefaction first motions. Nodal planes are indeterminate from the P wave data alone.



S WAVE PROJECT

COAST OF PERU

AUG.29,1963 7.1S 81.6W

15-30-31 h=23 km. M=6.5

LEGEND

P WAVE DATA
- ○ Compression
- △ Dilatation

S WAVE DATA
- Good
- Doubtful
- Near (i > ic)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

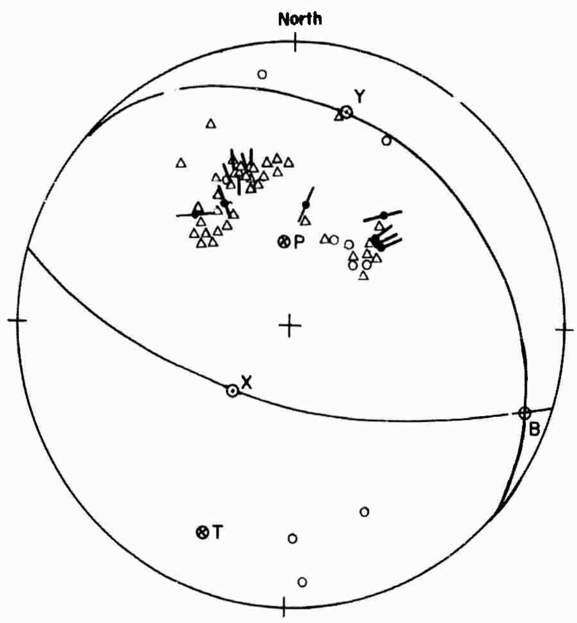
AXIS	AZ	PLUNGE
P	212	72
T	79	13
B	345	12
X	95	56
Y	248	31

Comment:

S wave data: N = 7 ; $\delta\bar{\epsilon} = 17.2^{\circ}$, $S_{\epsilon} = 24.9^{\circ}$

P wave data: 0 inconsistent of 33

While th: P and S wave data are not numerous for this earthquake, the solution shown is in excellent agreement with both these kinds of data.



S WAVE PROJECT

WESTERN BRAZIL
NOV. 9, 1963 9.0S 71.5W
21-15-30 h=600km. M=7

LEGEND

P WAVE DATA	S WAVE DATA
o Compression	Good
Δ Dilatation	Doubtful
	Near (i >ic)
⊗ P, T, & B Axes	⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	353	66
T	203	21
B	109	11
X	223.5	64
Y	13.3	23

Comment:

S wave data: N = 12 ; $\overline{\delta\epsilon} = 8.5^{\circ}$, $S_{\epsilon} = 10.2^{\circ}$

P wave data: 6 inconsistent of 49

This solution represents a satisfactory fit to the P wave first motion and an exceptionally good fit to the S wave data. The number of S wave data is not large, but the observations are of good quality. The large trace motion and tangling of the traces on the records prevented use of the S wave data at more stations.

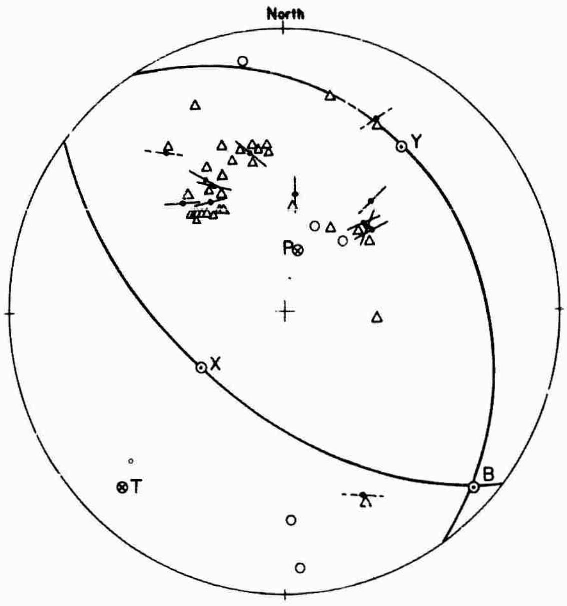
This earthquake was followed by a second shock in the same focus (see next page) only slightly smaller in magnitude. The radiation patterns of the two shocks are nearly identical.

S WAVE PROJECT

WESTERN BRAZIL

NOV. 10, 1963 9.2S 71.5W

01-00-39 h=600km. M=6.75



LEGEND

P WAVE DATA
o Compression
△ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P, T, & B Axes
⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	13	72
T	224	16
B	133	8
X	237	60
Y	37	29

Comment:

S wave data: N = 12 ; $\overline{\delta\epsilon} = 10.0^\circ$, $S_\epsilon = 13.7^\circ$

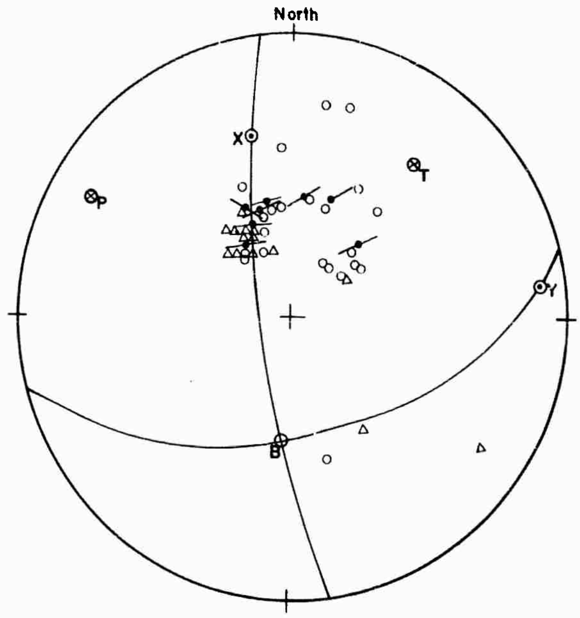
P wave data: 3 inconsistent of 37

This earthquake has virtually the same hypocenter as the preceding. The radiation patterns of P and S are quite similar, indicating an identical focal mechanism. In considering the S wave data one station was suppressed (LPA).. The error at this station was $\delta\epsilon = 88^\circ$. However, the station is located at an epicentral distance at which i_h changes rapidly. The station is further located on the mechanism diagram (the point at N155°E) at a point at which the polarization changes rapidly. Taking into account LPA, $\overline{\delta\epsilon} = 16.^\circ$, $S_\epsilon = 28.6^\circ$.

S WAVE PROJECT

COAST OF PERU

SEPT. 24, 1963 10.6S 78.0W
16-30-16 h=80 km. M=7



LEGEND

P WAVE DATA
- o Compression
- ▲ Dilatation

S WAVE DATA
- Good
- Doubtful
- Near (I > Ic)

⊗ P, T, & B Axes   ⊙ Nodal Plane Poles

MECHANISM SOLUTION

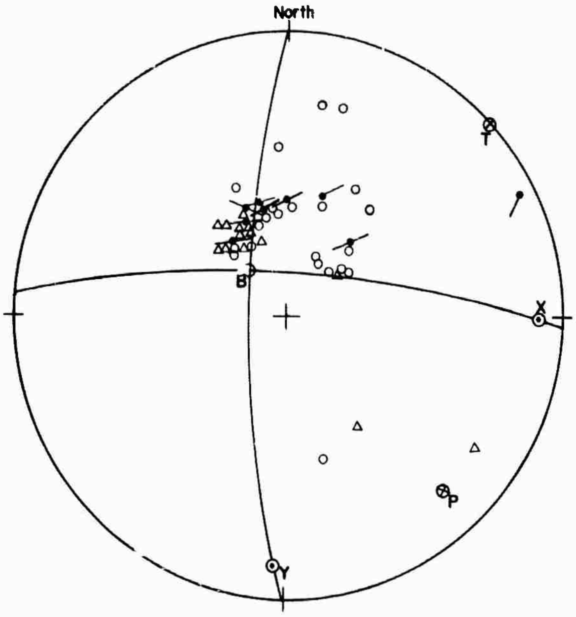
AXIS	AZ	PLUNGE
P	299	16
T	39	32
B	186	53
X	345	35
Y	83	10

Comment: (see alternate solution)

S wave data: N = 8 ; $\delta\bar{\varepsilon} = 14.8^{\circ}$, $S_{\varepsilon} = 21.4^{\circ}$

P wave data: 7 inconsistent of 38

The plane striking north-south is well determined by the evident transition from a rarefaction to a compression first-motion field of P and by the polarization data. The second plane is determined as the best fit to the S wave data. An alternate solution, which regards one additional P wave first-motion point, is given on the page which follows.



S WAVE PROJECT

COAST OF PERU

SEPT. 24, 1963 10.6S 78.0W

16-30-16 h=80km M=7

LEGEND

P WAVE DATA
o Compression
△ Dilatation

S WAVE DATA
Good
Doubtful
Near (I > Ic)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

ALTERNATE MECHANISM SOLUTION

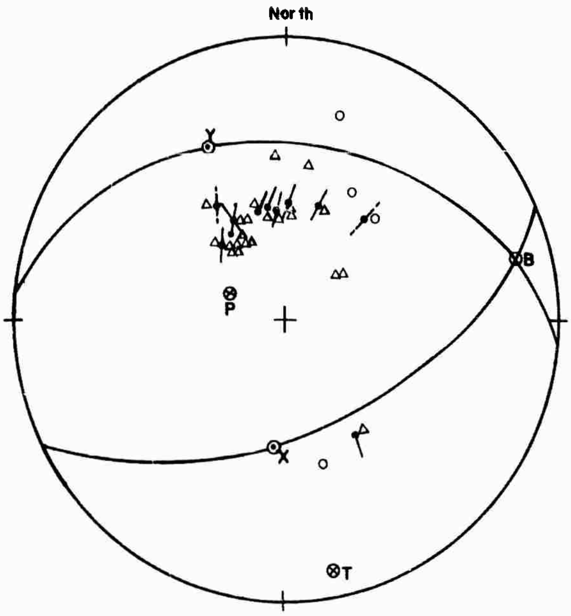
AXIS	AZ	PLUNGE
P	137	18
T	47	0
B	318	72
X	90	12
Y	183	12

Comment: (Alternate Solution)

S wave data: N = 8 ; $\delta\bar{\epsilon} = 16.9^{\circ}$, $S_{\epsilon} = 21.7^{\circ}$

P wave data: 6 inconsistent of 38

This is an alternate solution to that shown on the preceding page. One nodal plane is essentially unaffected. The position of the other represents the variation possible in the solution.



S WAVE PROJECT

CENTRAL PERU

SEPT. 17, 1963 10.6S 78.2W

05-54-34 h=61 km. M=6.75

LEGEND

P WAVE DATA
- ○ Compression
- △ Dilatation

S WAVE DATA
- Good
- Doubtful
- Near (i > ic)

⊗ P, T, & B Axes

⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	296	72
T	168	12
B	76	14
X	185	54
Y	335	32

Comment: (See Alternate Solution)

S wave data: N = 11 ; $\delta\bar{\epsilon} = 5.1^{\circ}$, $S_{\epsilon} = 8.5^{\circ}$

P wave data: 3 inconsistent of 28

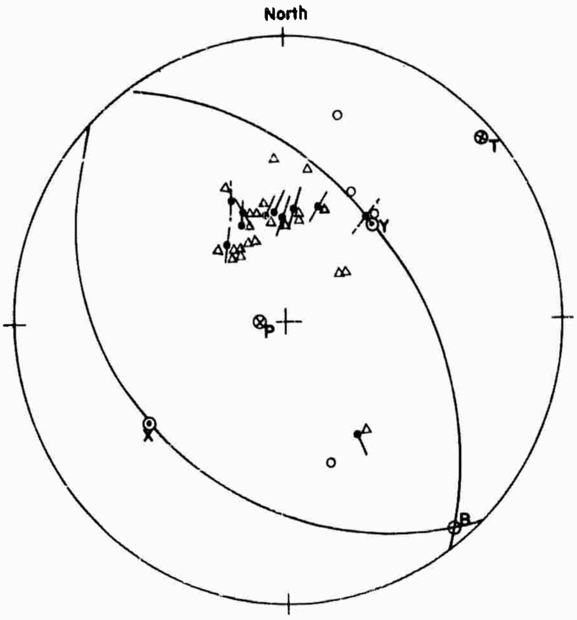
Agreement with the S wave data is very good. Though limited in azimuthal distribution, these data fix very closely the position of the P axis. The strike of the nodal planes permits of greater variation. See alternate solution which follows.

S WAVE PROJECT

CENTRAL PERU

SEPT. 17, 1963 10.6S 78.2W

05-54-34 h=61km M=6.75



LEGEND

P WAVE DATA
o Compression
Δ Dilatation

S WAVE DATA
Good
Doubtful
Near (i>ic)

⊗ P, T, & B Axes

⊙ Nodal Plane Poles

ALTERNATE MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	272	82
T	49	5
B	140	6
X	234	38
Y	43	51

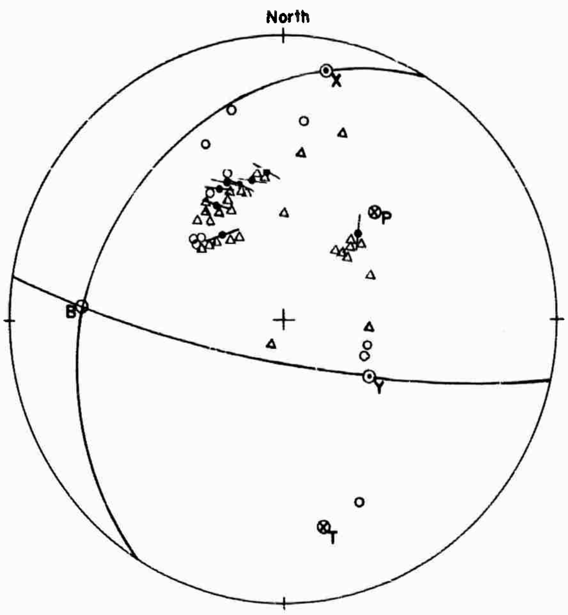
Comment:

S wave data: N = 11 ; $\delta\bar{\epsilon}$ = 16.7°, S_{ϵ} = 19.7°

P wave data: 1 inconsistent of 28

This solution favors the P wave data, though it is not a notable improvement even in this regard over the preceding solution.

S WAVE PROJECT



PERU-BOLIVIA BORDER
AUG.15,1963 13.8S 69.3W
17-25-06 h=543km. M=8

LEGEND

P WAVE DATA
- o Compression
- ◿ Dilatation

S WAVE DATA
- Good
- Doubtful
- Near (i>ic)

⊗ P,T,&B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

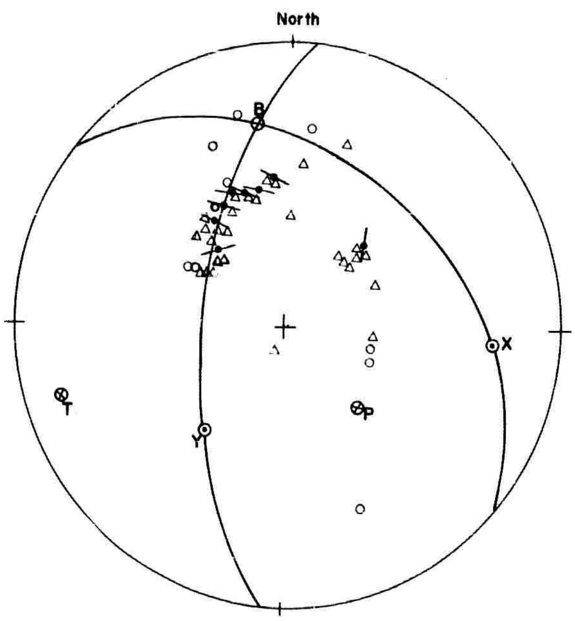
AXIS	AZ	PLUNGE
P	41	60
T	169	27
B	274	6
X	9	13
Y	122	60

Comment:

S wave data: N = 8 ; $\delta\bar{\varepsilon} = 6.6^{\circ}$, $S_{\epsilon} = 8.6^{\circ}$

P wave data: 10 inconsistent of 39

This solution, as the following alternate, is based on the S wave data, with no careful regard for the P wave first motions. While the P wave data are not in good agreement with the solutions proposed, the central field is clearly rarefaction first motion.



S WAVE PROJECT

PERU-BOLIVIA BORDER
AUG.15,1963 13.8S 69.3W
17-25-06 h=543 km M=8

LEGEND

P WAVE DATA
o Compression
Δ Dilatation

S WAVE DATA
Good
Doubtful
Near (I>ic)

⊗ P,T,&B Axes

⊙ Nodal Plane Poles

ALTERNATE
MECHANISM SOLUTION

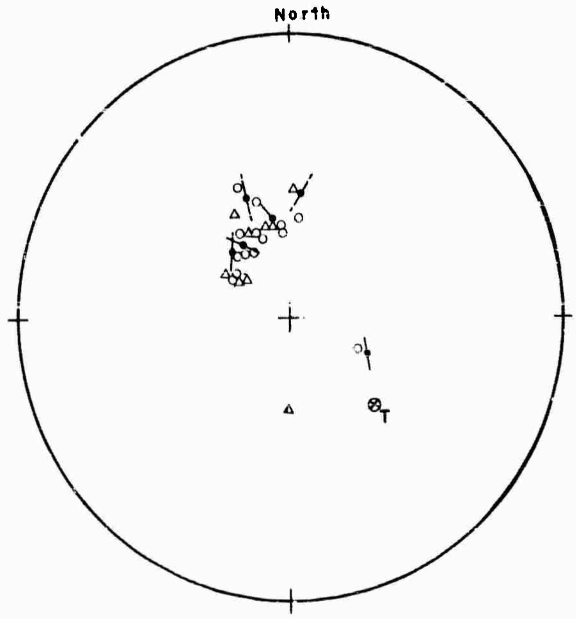
AXIS	AZ	PLUNGE
P	137	58
T	253	14
B	351	28
X	94	24.5
Y	219	52

Comment: (Alternate Solution)

S wave data: N = 8 ; $\delta\varepsilon = 9.6^\circ$, $s_\varepsilon = 13.1^\circ$

P wave data: 10 inconsistent of 39

This solution, as the preceding or alternate solution, is based on the S wave data, with no careful regard for the P wave first motions. While the P wave data are not in good agreement with the solutions proposed, the central field is clearly rarefaction first motion.



S WAVE PROJECT

NORTHERN CHILE

DEC.3, 1963 22.4S 69.3W

23-03-42 h=18km. M=6.25

LEGEND

P WAVE DATA
o Compression
▲ Dilatation

S WAVE DATA
Good
Doubtful
Near (l ld

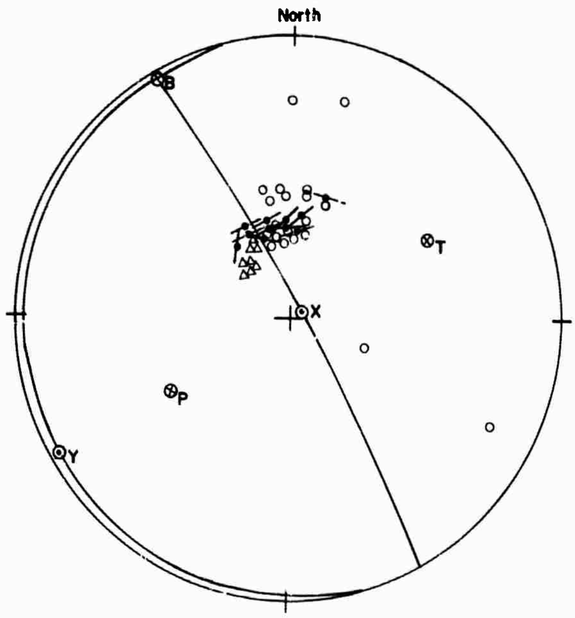
⊗ P,T,& B Axes ⊙ Nodal Plane Poles

NO MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P		
T		
B		
X		
Y		

Comment:

No solution proposed - data too few and too poor.



S WAVE PROJECT

CHILE

MAR.10,1963 29.9S 71.2W

10-51-48 h=70km. M=6.25

LEGEND

P WAVE DATA
- o Compression
- Dilatation

S WAVE DATA
- Good
- Doubtful
- Near (I > io)

⊗ P,T, & B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

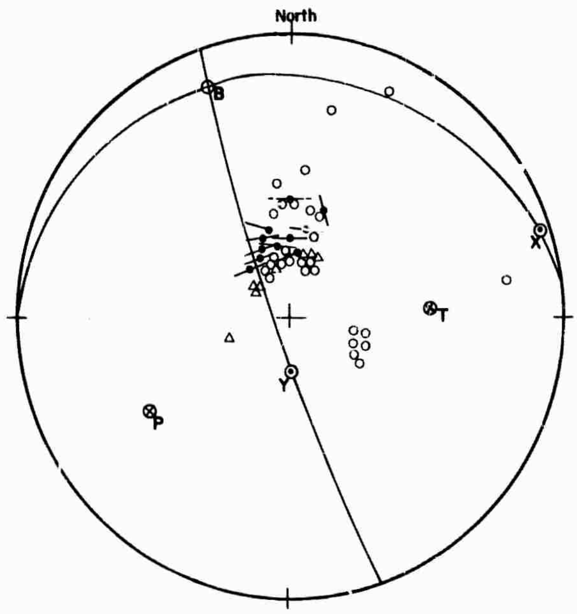
AXIS	AZ	PLUNGE
P	239	48
T	60	41
B	330	1
X	60	87
Y	240	3

Comment:

S wave data: N = 14 ; $\delta\bar{\varepsilon} = 12.9^{\circ}$, $S_{\varepsilon} = 17.2^{\circ}$

P wave data: 0 inconsistent of 30

In spite of a limited azimuthal distribution of data points, this solution is regarded as satisfactorily determined by the combination of P and S wave data. The nearly vertical nodal plane is well determined. The other nodal plane cannot depart significantly from a near-horizontal position.



S WAVE PROJECT

CHILE

FEB.5,1963 38.4S 73.2W

20-39-22 h=41km. M=6.5

LEGEND

P WAVE DATA
- o Compression
- △ Dilatation

S WAVE DATA
- Good
- Doubtful
- Near (i > ic)

⊗ P,T,& B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	237	38
T	86	48
B	239	15
X	70	5
Y	180	76

Comment:

S wave data: N = 13 ; $\delta\bar{\epsilon} = 14.9^{\circ}$, $S_{\epsilon} = 24.5^{\circ}$

P wave data: 5 inconsistent of 40

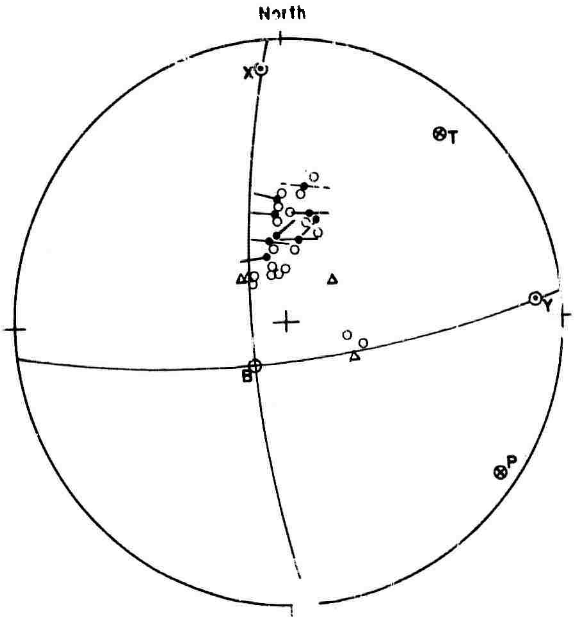
The combination of P and S wave data makes possible a fair solution. The rarefaction quadrant is not as well defined as might be desired, but the position of the near-vertical nodal plane seems to be satisfactorily determined.

S WAVE PROJECT

CHILE

MAY 19, 1963 46.5S 75.1W

01-03-04 h=33 km. M=6.75



LEGEND

P WAVE DATA
o Compression
Δ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P,T, & B Axes ⊙ Nodal Plane Poles

TENTATIVE
MECHANISM SOLUTION

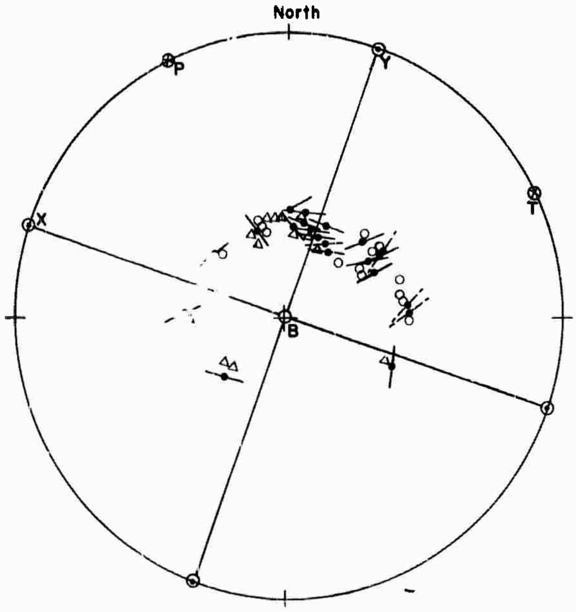
AXIS	AZ	PLUNGE
P	125	6
T	41	16
B	214	74
X	13	355
Y	10	87

Comment:

S wave data: N = 9 ; $\delta\bar{\epsilon} = 15.1^{\circ}$, $S_{\epsilon} = 20.1^{\circ}$

P wave data: 1 inconsistent of 22

This is a tentative solution. The P wave data are too few and the S wave data too few and of less reliable quality for a reliable solution. In all probability too much account is given a single rarefaction in determining the orientation of the nodal plane whose strike is approximately east-west. A solution closely resembling those of February 5 and March 10, 1965 (see above) could also be given.



S WAVE PROJECT

WEST OF EASTER ISLAND
MAR. 7, 1963 27.0S 113.5 W
05-22-01 h=33 km. M=6.75

LEGEND

P WAVE DATA
o Compression
Δ Dilatation

S WAVE DATA
Good
Doubtful
Near (I>Ic)

⊗ P,T,&B Axes
⊙ Nodal Plane Poles

MECHANISM SOLUTION

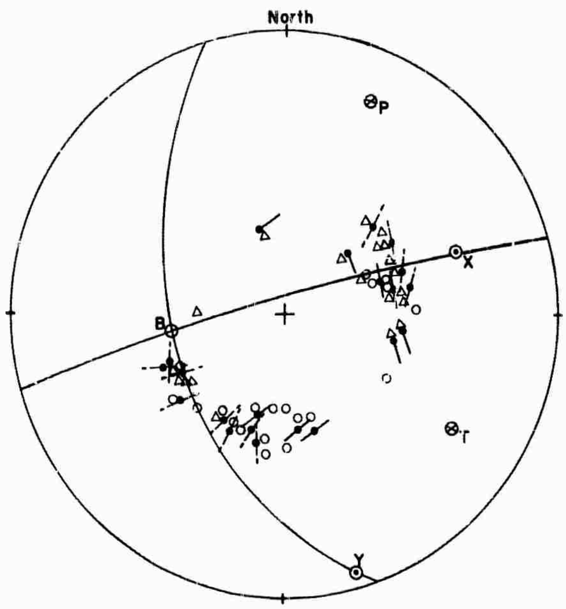
AXIS	AZ	PLUNGE
P	334	0
T	64	0
B	—	90
X	109	0
Y	20	0

Comment:

S wave data: N = 21 ; $\delta\bar{\epsilon} = 16.7^\circ$, $S_\epsilon = 22.4^\circ$

P wave data: 8 inconsistent of 27

The solution selected is accommodated to the S wave data. No solution is satisfactory to both P and S wave data; consequently two vertical planes were simply chosen as representing approximately the mechanism diagram. The S wave data are of good quality.



S WAVE PROJECT

BAFFIN ISLAND

SEPT. 4, 1963 71.4N 73.3W
13-32-12 h=33 km. M=6.5

LEGEND

P WAVE DATA
○ Compression
△ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

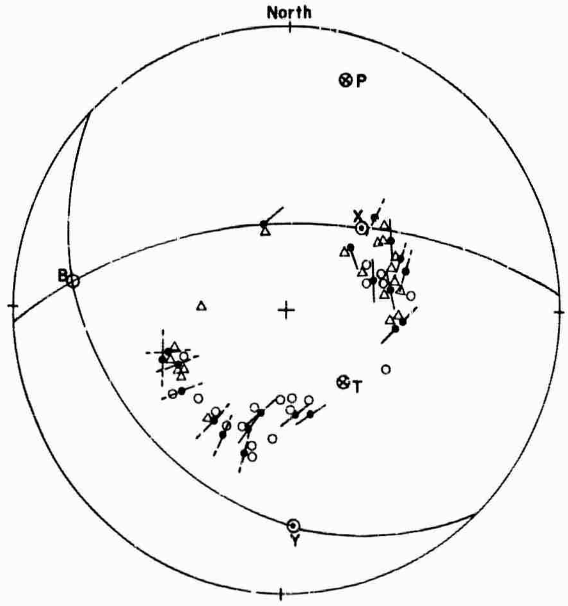
AXIS	AZ	PLUNGE
P	22	19
T	122	28
B	262	56
X	61	34
Y	163	7

Comment: Tentative Solution; see also next page.

S wave data: N = 21 ; $\delta\bar{\epsilon} = 29.2^{\circ}$, $S_{\epsilon} = 36.4^{\circ}$

P wave data: 9 inconsistent of 42

Neither the P nor the S wave data for this earthquake are of good quality. The nodal lines are ill-defined (many inconsistent points in the vicinity of the nodal lines), but the solution here proposed is not greatly in error. See also an alternate solution on the page which follows. The alternate solution was obtained by a computer program which ignores the P wave data and searches for the S wave solution which best fits the polarization data. Both solutions together indicate probable limits of variation.



S WAVE PROJECT

BAFFIN ISLAND
SEPT. 4, 1963 71.4N 73.3W
13-32-12 h=33 km. M=6.5

LEGEND

P WAVE DATA
○ Compression
△ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P, T, & B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

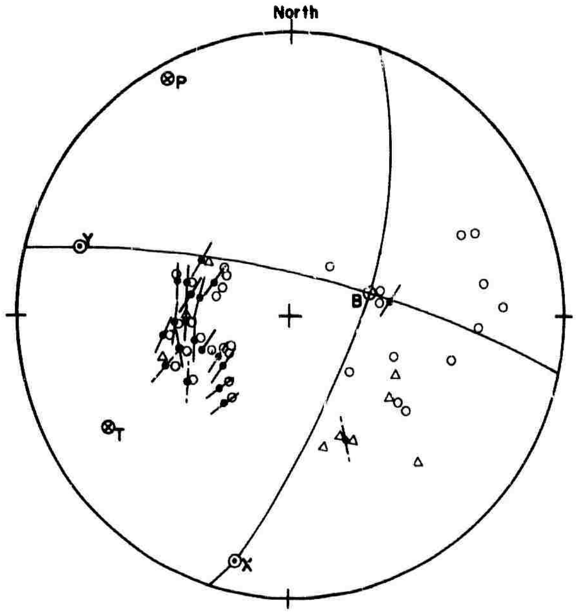
AXIS	AZ	PLUNGE
P	14	17
T	140	62
B	277	21
X	43	56.5
Y	177	24.5

Comment: Alternate Solution; see also preceding page.

S wave data: N = 21 ; $\delta\bar{\epsilon} = 19.5^\circ$, $S_\epsilon = 24.5^\circ$

P wave data: 20 inconsistent of 42.

See comments on preceding page.



S WAVE PROJECT

ICELAND

MAR.28,1963 66.3N 19.6W
00-15-48 h=15 km. M=7.25

LEGEND

P WAVE DATA
o Compression
Δ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P,T,& B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

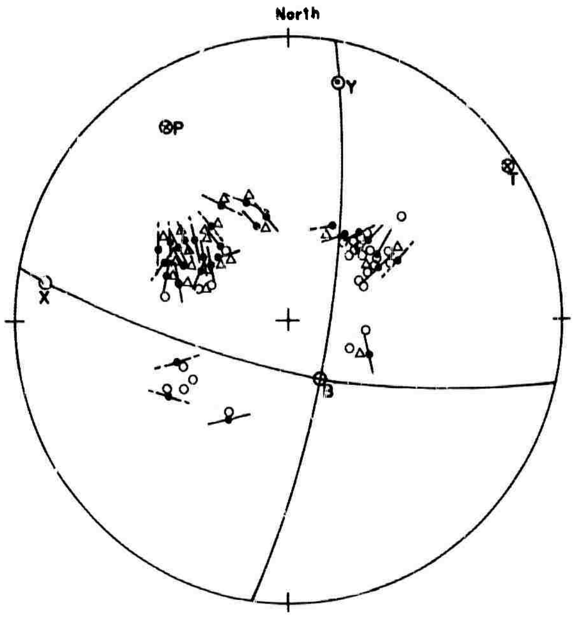
AXIS	AZ	PLUNGE
P	321	5
T	239	24
B	73	66
X	193	13
Y	287	20

Comment:

S wave data: N = 20 ; $\delta\varepsilon = 17.7^\circ$, $S_\varepsilon = 23.0^\circ$

P wave data: 10 inconsistent of 43

This solution gives preference to the S wave data. Adjustments of 20° or so in the nodal planes would make possible a 50% improvement in the P wave consistency score. The solution is fair.



S WAVE PROJECT

NORTH ATLANTIC

MAY 19, 1963 23.8N 45.9W
21-35-50 h=33km. M=6.5

LEGEND

P WAVE DATA
o Compression
Δ Dilatation

S WAVE DATA
Good
Doubtful
Near (i > ic)

⊗ P, T, & B Axes
⊙ Nodal Plane Poles

MECHANISM SOLUTION

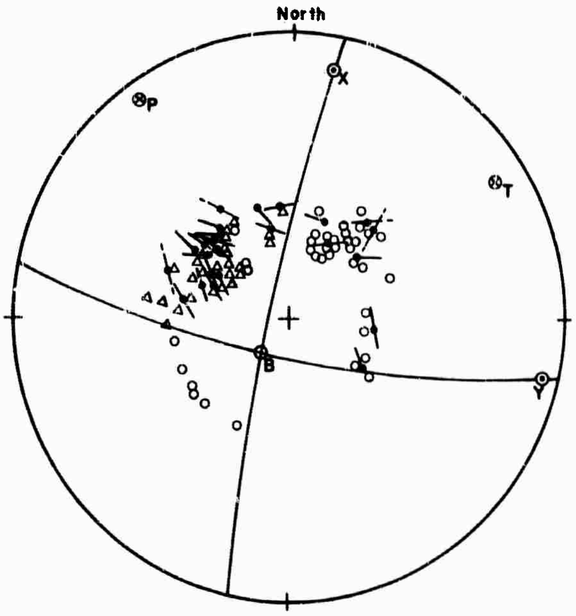
AXIS	AZ	PLUNGE
P	327	19
T	56	2
B	151	72
X	279	10
Y	11	14

Comment:

S wave data: N = 30 ; $\delta\bar{\varepsilon} = 22.7^{\circ}$, $S_{\epsilon} = 28.4^{\circ}$

P wave data: 7 inconsistent of 50

This solution is satisfactory. While the variance of the S wave polarizations is a little large, the solution is in agreement with both the P and the S wave data. The solution resembles the well documented solution of November 17, 1965, as also the solution for August 3, 1965, both also for earthquakes of the North Atlantic. See the following page.



S WAVE PROJECT

NORTH ATLANTIC

AUG. 3, 1963 7.7N 35.8W

10-21-37 h=33km. M=6.25

LEGEND

P WAVE DATA
o Compression
Δ Dilatation

S WAVE DATA
Good
Doubtful
Near (i>ic)

⊗ P,T,&B Axes
⊙ Nodal Plane Poles

MECHANISM SOLUTION

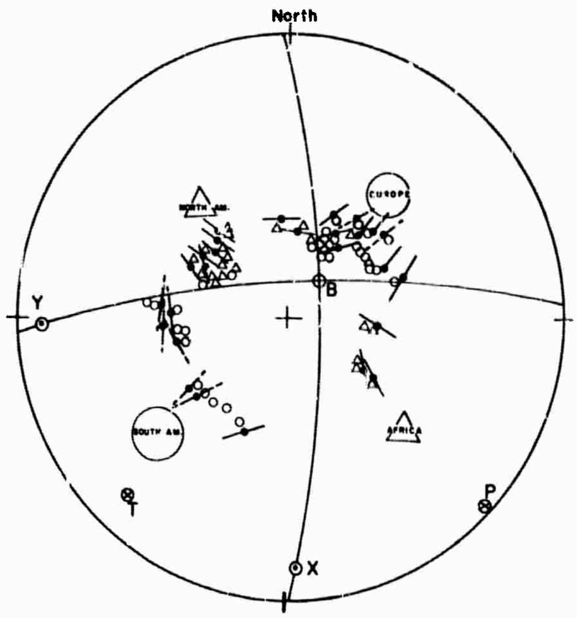
AXIS	AZ	PLUNGE
P	325	5
T	57	12
B	222	78
X	11	10
Y	102	4

Comment:

S wave data: N = 27 ; $\delta\bar{\epsilon} = 16.1^\circ$, $S_\epsilon = 20.9^\circ$

P wave data: 4 inconsistent of 73

This is a very good solution, in excellent agreement with both the P and the S wave data.



S WAVE PROJECT

NORTH ATLANTIC

NOV. 17, 1963 7.6N 37.4W

00-48-03 h=33km. M=6.5

LEGEND

P WAVE DATA
- ○ Compression
- △ Dilatation

S WAVE DATA
- Good
- Doubtful
- Near ($i > i_c$)

⊗ P,T,&B Axes ⊙ Nodal Plane Poles

MECHANISM SOLUTION

AXIS	AZ	PLUNGE
P	133	3
T	223	13
B	37	76
X	177	12
Y	269	9

Comment:

S wave data: N = 26 ; $\delta\bar{\epsilon}$ = 17.6°, S_{ϵ} = 20.7°

P wave data: 5 inconsistent of 64.

This is an excellent solution, exceptionally well documented, with both P and S wave data in all four quadrants. The mechanism is explainable only by a double couple point source equivalent. This solution offers a strong demonstration of the agreement of both the P and the S wave radiation patterns with the same focal mechanism orientation and of the representation of an earthquake source by a double couple.

APPENDIX 2

Tabulation of All P and S Wave Data

Listed on the following pages are the P wave first motion data and the S wave polarization data for all the earthquakes studied. The station symbols which are underlined represent P wave first motions which are inconsistent with the solutions given in Appendix 1.

January 1, 23^h, 56.6N, 157.7W, Alaska Peninsula

P Wave Data:

Compressions: ABJ AFI AIK ALE APA ATU BNS CHZ CLS
CNT COP FIR GOT GRC HAK HKC HMM IID ISN KEV
KEW KIR KJN KSA KYO LHA LJU LWI MAN MAT MBC
MDS MED MES MIS MOR MRK NAG NEM NGS NUR OSH
PAD PAR PET RES REY ROM RSL SAP SEN SID SKA
STU STR TAS TKM TOL TYK UME UPP WAK WAR WIT
YAK YAM ZSC. KUR KUS

Rarefactions: AAA AAM ALQ ASA BAN BHP BKS BLO BMO
CAR? COR DAL DUG FAY GEO GOL HAL HVO KIP LEM
LND LON LPS LUB MHC MNT OTT? PAS PNT? ROL SCH
SCP SHA SHS SVE TUC VIC WMO YKC.

S Wave Data: $\delta\varepsilon$ = 12.8 S_ε = 21.0 N = 23

Sta.	Δ	Az	i_o	ε_o	$\varepsilon_o - \varepsilon_c$	Grade
ALE	35.0	13	38.5	83.6	+14.1	Near
ALQ	40.6	100	37	-20.4	-10.2	Near
BHP	76.0	95	26	0.0	+ 0.6	Good
BKS	30.0	113	39.5	-29.3	- 0.4	Near
BLO	48.5	79	34.5	15.8	- 0.8	Doubtful
COP	67.8	6	28.5	56.7	-20.0	Good
COR	24.6	104	42.5	-54.2	-34.0	Near
DAL	47.5	93	34.5	- 3.3	- 2.9	Good
GOL	37.7	94	37.5	-23.7	-21.2	Near
HAL	56.3	59	32	40.3	+ 3.1	Doubtful
KEV	53.9	358	33	74.6	- 3.4	Doubtful
LND	48.6	72	34.5	31.8	+ 7.2	Good
LON	24.1	99	43	63.5	+76.5	Near
LUB	44.1	97	35.5	-13.1	- 7.4	Near
MAN	73.1	271	27	90.0	+ 5.9	Good
MBC	24.1	21	44.5	63.0	- 3.6	Near
MDS	43.8	77	35.5	34.3	+15.2	Near
PNT	23.8	92	44.5	-29.1	-26.9	Near
ROL	46.5	85	35	1.6	- 7.8	Doubtful
SCP	51.9	72	33.5	32.1	+ 7.8	Doubtful
SHA	53.9	88	33	17.0	+11.0	Doubtful
TUC	40.3	107	37	-30.1	-11.0	Near
WES	54.2	66	33	35.1	+ 4.6	Doubtful

January 28, 13^h, 54.7N, 161.6W, Alaska Peninsula

P Wave Data:

Compressions: ALE BAG BRA CNT CNU COI COP DBN FIR
GOT GRC KEV KHO KIR KLS KRS KRV KUN LCC LHA
LJU MAE MAG MAL MAN MAT MHC NGS NHA NUR OBM
PDA PET PMG RES RIV ROM SIA SIM SKA SOD STR
STU TIK TOL UME UPP WIT.

Rarefactions: AAA AAM ASA ATU BKS BRK CAR? CHN CLS
COR? DUR HAL? HVO KOC LEM MES MNT PLN? PRI SCH
SVE TUC? VIC? VYB.

S Wave Data: $\delta\bar{\varepsilon} = 9.1°$ $S_c = 14.9°$ N = 2

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
COR	26.5	97	40	78.3	- 3.8	Near
MAN	70.8	268	27	-76.6	+14.4	Doubtful

February 5, 20^h, 38.4S, 73.2W, Coast of Chile

P Wave Data:

Compressions: ALQ ANT? ARE BEC BHA BHP BLO BOG BUL
CAR CHN CLS CPO DAL KIM LND LPA LUB LWI NNA
OTT ROL SAN SCP SOB TOL TUC VBO WIN.

Rarefactions: AFI BKS CON GEO MHC MNT MRG PRI SHA?
TRN? TUL.

S Wave Data: $\delta\bar{\varepsilon} = 14.9$ $S_c = 24.5$ N = 13

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
ALQ	79.2	333	24.5	-79.0	+ 1.2	Good
BEC	70.9	8	27	90.0	+ 8.0	Good
BHP	47.5	351	34	55.1	-40.1	Doubtful
BLO	78.2	349	25	-73.5	+15.8	Good
BOG	42.8	359	35	-88.8	- 3.7	Near
DAL	74.2	340	26	-80.0	+ 4.1	Good
GEO	77.0	357	25	90.0	- 5.2	Good
LUB	76.4	336	25.5	-72.4	+ 9.6	Good
ROL	77.9	345	25	-75.7	+11.4	Good
SCP	78.9	356	24.5	90.0	+ 3.6	Doubtful
SHA	70.1	346	27.5	-66.6	+20.1	Doubtful
TRN	50.0	15	33.5	-23.0	+67.8	Good
TUC	78.5	328	25	-74.6	+ 2.8	Good

March 7, 05^h, 27.0S, 113.5W, West of Easter Island

P Wave Data:

Compressions: ARE BEC BHP BKS BOG CAR HVO LPB MHC
NNA QUI SHS TRN.

March 7, 05^h Continued.

P Wave Data Continued:

Rarefactions: AAM? AFI CAN CLS COR GOL LPA LUB PLM PRI TAU? TUC TUL.

S Wave Data: $\delta\bar{\epsilon}$ = 16.7 S_ϵ = 22.4 N = 21

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	74.2	23	26	74.5	- 8.3	Good
AFI	55.7	271	31.5	-24.4	+32.1	Good
ARE	40.2	84	36.5	-24.0	+20.6	Near
BHP	48.6	47	34	15.9	-23.7	Good
BLO	70.5	22	27	-84.4	+11.0	Good
BOG	49.4	57	33.5	5.0	-12.5	Good
CAR	58.6	57	30.5	17.4	+ 0.4	Good
COR	71.8	353	26.5	-35.0	+ 5.8	Good
GOL	66.8	7	28.5	-64.2	+ 4.3	Good
KIP	64.6	314	29	-87.7	+46.8	Doubtful
LPA	47.8	114	34	76.8	- 6.5	Good
LPB	43.2	86	35	-17.5	+30.6	Near
LUB	61.3	11	30	-79.6	- 3.6	Good
QUI	42.9	57	35	-18.3	-36.1	Near
RCD	71.4	8	27	-46.7	+23.4	Good
ROL	67.7	18	28	75.5	- 6.3	Good
SHA	62.3	25	29.5	72.9	- 6.6	Good
TAU	78.4	228	25	53.3	+18.3	Good
TRN	62.9	61	29.5	0	- 7.9	Good
TUC	59.0	3	30.5	72.7	-45.7	Doubtful
WES	79.2	30	24.5	70.3	+ 0.5	Good

March 10, 10^h, 29.9S, 71.2W, Coast of Central Chile

P Wave Data:

Compressions: AAM ARE BEC BHP BKS BOG CAR CHN GEO LPA LPB MDS QUI RCD ROL SCP SHA TRN TUL WES WIN.

Rarefactions: ALQ CLS GOL LUB MHC PLM PRI SHS TUC

S Wave Data: $\delta\bar{\epsilon}$ = 12.9 S_ϵ = 17.2 N = 14

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	72.7	350	27	77.7	+ 3.9	Good
ALQ	72.6	330	27	88.9	+ 1.6	Good
BEC	62.2	6	30.5	44.7	+19.6	Good
DBQ	74.2	345	26.5	62.5	-14.6	Good
GEO	68.7	355	28	61.1	- 9.5	Good

March 10, 10^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
GOL	76.2	333	26	-78.9	+15.8	Good
LUB	69.5	333	28	-87.7	+ 7.0	Good
RCD	79.2	337	25	-74.6	+22.9	Good
ROL	70.2	343	27.5	78.8	+ 0.0	Good
SCP	70.6	355	27.5	83.2	+12.9	Good
SHA	62.4	344	30	71.7	- 7.1	Good
TRN	41.4	15	36	77.7	+22.0	Near
WES	71.9	0	27	62.4	- 4.0	Good

March 16, 08^h, 46.5N, 154.7E, Kurile Islands

P Wave Data:

Compressions: AAA AFI ALQ ANR APA ATU? BAG BEC BEO
BHP BKS BLO BRK BRS CLS CNU COR CTA DAL DJA
DUG FAY GEO GOL GOT GRC GRS HVO IST KAT KEV
KHO KIP KIR KLS LAH LON LUB LWI MAN MBC MRG
MUN NDI NHA NOU NUR OTT PAL PAV PDA PLM PMG
PNT PRI QUE RAB RCD RES RIV ROL SCH SCP SEA
SFA SHA SIC SIM SOD STU TAP TAS TIK TOL TUC
UBO UME UPP VIC VYB YKC.

Rarefactions: ADE CNH FIR FRU IRK KOU KRL LJU MHC
REY? SFA? SLC STR TNG TUL VLA.

S Wave Data: δz = 16.9 δ_ϵ = 22.8 N = 17

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
BLO	78.7	44	25	22.9	-16.0	Good
COR	54.9	60	32	28.8	- 3.2	Doubtful
GOL	68.4	55	28	44.4	+10.3	Doubtful
IST	80.3	321	24	33.6	+33.6	Doubtful
KEV	57.9	341	31	-44.6	-49.2	Doubtful
KIP	45.6	107	34.5	0.0	+ 0.8	Good
LAH	61.6	287	30	30.3	+30.6	Good
LUB	74.7	57	26	0.0	-33.1	Good
NHA	51.3	243	33	24.9	+18.8	Doubtful
DMG	56.1	189	31.5	0.0	+38.2	Good
PNT	54.5	53	32	30.7	- 4.6	Doubtful
RAB	50.5	183	33	-32.3	+ 6.8	Doubtful
RCD	66.6	50	28.5	38.4	+ 2.0	Doubtful
RIV	80.0	183	24.5	-48.3	-58	Good

March 16, 08^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o-\epsilon_c$	Grade
ROL	77.0	48	25.5	44.1	+ 6.7	Good
SCH	73.2	24	26.5	28.3	-13.0	Doubtful
TUC	70.2	64	27.5	15.2	-14.2	Good

March 26, 21^h, 36.0N, 135.7E, East Coast, Honshu, Japan (Tentative Solution)

P Wave Data:

Compressions: ADE ALE ATU? BAG BKS BLO COP CTA FIR GOT HNR IST KEW KIR KLS LAH LAH LWI MAN MBC MHC MUN NHA NUR PAS PNT PRA PRI QUE RES RIV ROL ROM SEA SHS SKA TUL UME UPP VIC.

Rarefactions: AFI BRS CLS COR FAY HVO MNT RAB? SOD TOL.

S Wave Data: $\delta\bar{\epsilon}$ = 18.8 S_ϵ = 24.5 N = 15

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o-\epsilon_c$	Grade
ADE	70.7	177	27	-16.1	-10.9	Doubtful
BKS	77.1	53	25.5	-77.8	+ 1.8	Good
COP	76.7	331	25.5	68.0	-26.6	Good
COR	72.6	47	26.5	-66.8	+ 5.3	Good
CTA	56.7	168	31.5	-17.2	+ 1.3	Doubtful
HNR	50.6	148	33	-24.9	-15.0	Doubtful
IST	78.1	312	25	-42.2	+22.5	Good
MBC	58.8	16	30.5	11.3	+ 2.1	Doubtful
NHA	33.6	232	38	38.2	- 2.2	Near
NUR	68.6	330	27.5	74.3	-23.9	Good
QUE	56.8	285	31	-84.2	-52.2	Good
RES	64.7	13	29	- 6.1	-25.6	Doubtful
RIV	71.0	166	27	28.2	+34.9	Doubtful
TAU	79.2	171	24.5	-32.5	-30.9	Doubtful
VIC	70.4	44	27	-41.7	+26.2	Good

March 28, 00^h, 66.3N, 19.6W, Iceland

P Wave Data:

Compressions: ALQ BEC BHP BKS BLO BOG CHN CLS DAL FIR GEO GOL JER KIR KLS LAH LPS LWI MAN? PLM PRI QUE QUI RCD ROL SHA SKA SOD STR TRN TUC UME UPP.

Rarefactions: ATU CAR COR KEW LIS MAL MNT ROM TOL TUL.

March 28, 00^h, Continued

S Wave Data: $\delta\bar{\epsilon}$ = 17.7 S_ϵ = 23.0 N = 20

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o-\epsilon_c$	Grade
ALQ	57.3	283	31	-76.1	+11.5	Good
BEC	43.2	241	35	-54.8	+42.8	Near
BHP	70.0	245	27.5	-41.6	+21.2	Doubtful
BLO	45.7	268	34.5	-55.0	+14.4	Good
BOG	72.1	238	26.5	-19.9	+15.4	Good
CAR	64.2	233	29	10.5	+ 2.4	Good
COR	55.2	302	32	90.0	+21.8	Good
DAL	55.3	273	31.5	88.8	+16.8	Good
GEO	42.1	259	35.5	-30.6	+24.6	Near
GOL	52.8	285	32.5	82.9	+ 6.0	Good
LPS	68.8	257	27.5	-73.2	+28.3	Good
PLM	62.8	291	29.5	82.0	+ 1.1	Good
QUE	61.4	80	30	-37.0	+28.9	Good
QUI	78.1	241	25	-24.8	+13.6	Good
RCD	48.2	286	34	78.0	+ 8.9	Good
ROL	48.9	272	33.5	-68.7	+ 5.8	Good
SHA	53.7	264	32	63.4	+55.7	Good
TRN	62.3	228	29.5	13.1	+ 7.6	Good
TOL	27.9	154	39	- 8.6	+26.0	Near
TUC	61.4	285	30	90.0	+ 0.4	Good

March 30, 15^h, 44.2N, 148.0E, Kurile Islands

P Wave Data:

Compressions: AAB ALQ ANR ATU BAG BKS BLO BMO BNS BRA BRK CFF CHZ CLS CNU COP CPO DBN FRU GDH GOL GOR GOT HAL HVO IST KAT KEW KHO KIR KLS KRV KUN LHA LJU LON MAG? MAN MBC MDS MHC MNT MRG NOU NUR OBM PAS PHC PRI PUL QUE RCD RES ROL SEA SEM SFA SHS SIM STU TAS TIK TNG TRI TUC UME UPP WMO YAK.

Rarefactions: AFI? APA CAN DJA DUK KHE KJN MAT MDS MLH MUN NHA PMO PET SCH? SEO SHS SOD SVE TUL VYB.

S Wave Data: $\delta\bar{\epsilon}$ = 5.1 S_ϵ = 6.2 N = 6

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o-\epsilon_c$	Grade
BAG	36.1	229	37.5	-30.0	- 4.8	Near
HNR	54.5	165	32	-21.6	+ 6.0	Doubtful

March 30, 15^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
IST	79.0	318	24.5	-42.3	- 4.0	Doubtful
NHA	46.0	238	34.5	-25.4	- 3.0	Doubtful
NUR	65.9	333	28.5	-39.3	- 9.9	Doubtful
RAB	48.3	174	34	-31.1	- 4.8	Doubtful

April 2, 16^h, 53.2N, 171.7W, Aleutian Islands

P Wave Data:

Compressions: CAN DAL.

Rarefactions: AAM AFI ALQ BAG BEC BKS BLO BOG CAR CAN CLS COR GEO GOL GOT HEL HNR IST KEV KIR KLS LND? LON LWI? MBC MHC MNT NHA NUR PAL PAS PLM? PRI PRU QUE RAB REY? RIV ROL SEO SHS SKA SOD TOL UME UPP.

S Wave Data: $\delta\bar{\epsilon}$ = 20.2 S_ϵ = 34.1 N = 9

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	56.5	63	33.5	37.9	+15.6	Doubtful
ALQ	48.5	85	35.5	5.7	- 1.7	Doubtful
BKS	37.1	94	39.5	-15.7	-15.0	Near
BLO	57.2	167	33.5	38.8	+19.0	Doubtful
COR	32.4	86	41	- 3.0	- 6.2	Near
GOL	46.0	79	36.5	- 8.1	-18.5	Doubtful
NUR	65.9	351	30.5	24.6	- 1.3	Doubtful
* OGD	62.2	58	31.5	-64.6	-88.7	Doubtful
ROL	55.1	72	34	32.0	+15.6	Doubtful

* Without OGD: $\delta\bar{\epsilon}$ = 11.6 S_ϵ = 14.4

April 13, 02^h, 6.2S, 76.5W, Central Peru

P Wave Data:

Compressions: AFI ARE BOG REY.

Rarefactions: AAM ALQ ANT ATU BEC BHA BHP BKS BLO BUL CAR CLS DAL GEO GOL GOT KEW KIR KLS LIS LJU LON LPS LWI MAL MHC MNT PAS PLM PRA PRI PRU QUI ROL ROM SAN SCP SHA SKA STR TOL TRN TUC UME UPP WES.

S Wave Data: $\delta\bar{\epsilon}$ = 12.8 S_ϵ = 17.3 N = 15

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	48.7	353	35	-73.1	-11.7	Good
ALQ	49.7	327	35	-62.6	- 9.2	Good

April 13, 02^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o-\epsilon_c$	Grade
BKS	61.1	320	31.5	-54.8	- 5.0	Good
BLO	46.1	349	35	-85.1	-24.0	Good
DAL	43.4	335	37	-87.5	-30.9	Near
GOL	52.9	332	34	-57.3	- 1.2	Good
LON	66.2	328	30.5	-23.7	+31.2	Good
LPS	23.9	328	47.5	-68.4	-14.4	Near
MAL	79.5	51	25.5	16.3	-10.2	Good
PLM	54.9	318	33.5	-46.9	+ 1.6	Good
ROL	46.2	343	35	-77.9	-18.0	Good
TOL	80.7	48	25.5	17.3	+ 0.7	Good
TRN	22.5	42	46	20.3	+ 4.4	Near
TUC	50.3	322	35	-51.6	- 0.9	Good
WES	48.6	5	34.5	-30.8	+28.1	Doubtful

May 10, 22^h, 2.2S, 77.6W, Ecuador (No Solution)

P Wave Data:

Compressions: AAM ALQ BEC BEO BHP BLO COR DAL GEO GOL LON LPA LPS MAL PLM SCP SHA.

Rarefactions: CAR LIS LJU MNT OGD PDA? ROM TOL TRN.

S Wave Data:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o-\epsilon_c$	Grade
ALQ	45.8	326	34.5	41.5		Good
BEC	36.5	19	37	0.0		Near
COR	61.8	325	30	68.3		Good
DAL	39.3	334	36.5	34.9		Near
GOL	48.9	331	33.5	56.4		Good
LPA	37.3	153	37	56.3		Near
LPS	20.0	325	59	74.7		Near
PDA	62.3	45	29.5	-54.3		Good
SCP	42.8	0	35.5	65.9		Near
TOL	78.8	49	24.5	45.3		Good
TRN	20.6	51	51	90.0		Near

May 19, 01^h, 46.5S, 75.1W, Coast of Southern Chile (Tentative Solution)

P Wave Data: ANT ARE BEC BHP BLO BOG CAR CLS DBQ LWI MHC MHT NNA QUI ROL SHA TRN.

May 19, 01^h, Continued

P Wave Data Continued:

Rarefactions: BKS PIE PRI TOL

S Wave Data: $\delta\varepsilon$ = 15.1 S_e = 20.1 N = 9

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
ARE	30.1	7	38.5	90.0	+13.4	Near
BEC	79.1	9	24.5	73.6	+ 9.8	Good
BHP	55.4	355	31.5	90.0	+ 0.7	Doubtful
BLO	85.9	351	22.5	55.9	-33.6	Doubtful
CAR	57.2	10	31	73.8	+ 6.9	Good
MHT	87.5	343	22	-79.2	+ 0.1	Doubtful
QUI	46.2	355	34.5	-60.5	+28.7	Doubtful
SHA	77.7	349	25	-70.3	+15.6	Good
TRN	58.2	16	31	30.0	-26.8	Doubtful

May 19, 21^h, 23.8N, 45.9W, North Atlantic

P Wave Data:

Compressions: AQU ARE ATU BKS BOG CAR COP DAL? DBN BHP JER KEW KIM KSA LJU LND LWI MAL NUR PAD PAS PDA PNT? PRA ROM STR STU TOL.

Rarefactions: AAM ALQ BEO BLO COR GEO GOL GSC HAL KEV LIS MNT PAL RES ROL SCB SCH SCP TUC VIC WIN?.

S Wave Data: $\delta\varepsilon$ = 22.7 S_e = 28.4 N = 30

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	36.3	310	37	22.1	+14.0	Near
ALQ	53.2	297	32.5	44.1	+14.5	Good
AQU	52.0	54	32.5	12.7	+14.2	Doubtful
ARE	47.2	214	34	35.8	+18.7	Good
ATU	60.1	59	30.5	- 9.5	+28.6	Good
BHP	35.4	251	37	0	+51.2	Near
BKS	65.4	302	29	70.7	+25.0	Good
BLO	37.5	304	37	78.8	+29.0	Near
CAR	24.0	240	43	32.4	+63.6	Near
COP	52.9	37	32.5	16.2	+38.3	Good
COR	64.9	310	29	57.6	+28.4	Doubtful
GEO	30.4	307	38.5	42.0	+ 2.8	Near
GOL	52.1	303	32.5	26.0	+21.2	Doubtful
HAL	25.3	329	40.5	-21.2	+ 4.1	Near
KEV	62.0	22	30	55.2	+21.0	Doubtful

May 19, 21^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
LND	34.8	312	37.5	19.5	+12.2	Near
MAL	37.8	60	37	-14.5	+27.5	Near
MBC	63.1	345	29.5	-19.4	+28.2	Doubtful
NUR	60.0	33	30.5	34.9	+25.9	Doubtful
OTT	32.4	319	38	0	+12.9	Near
PNT	61.9	315	30	8.7	+10.0	Doubtful
RES	56.9	346	31	-26.3	+24.1	Good
ROL	41.5	301	35.5	70.6	+16.4	Near
SCB	33.8	314	37.5	23.7	+ 2.7	Near
SCH	34.6	339	37.5	-38.4	+ 2.7	Near
SCP	31.7	310	38	35.4	+ 1.8	Near
STU	49.7	45	33.5	- 1.7	+43.6	Good
TUC	57.2	310	31	38.6	+ 7.8	Good
VIC	64.4	314	29	-42.2	+62.6	Doubtful
WIN	76.6	122	25.5	52.2	+29.1	Good

May 22, 13^h, 48.6N, 154.7E, Kurile Islands

P Wave Data:

Compressions: AAM ADE ASZ ATU BAG BKS BLO COP COR CTA GOL GSC HKC HNR IST JER KEW KIP KSA LJU LON MAN MNT MUN NDI NGS NUR PAV PMG PRU RAB RIV ROL ROM SCB SEO SHI SHL SHS STR STU TUC YAM.

Rarefactions: AFI CLS LPS MAE MHC PAS PNT? PRI TOL.

S Wave Data: $\delta\bar{\epsilon}$ = 22.0 S_ϵ = 29.4 N = 23

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	75.9	41	25.5	-59.5	+22.5	Doubtful
BAG	42.5	235	35.5	31.5	+16.4	Near
BKS	58.6	67	31	16.4	-70.4	Doubtful
BLO	77.2	44	25	-50.2	+35.4	Doubtful
COP	71.4	339	27	-25.3	+ 2.1	Doubtful
HKC	41.5	245	36	53.4	+27.4	Near
HNR	58.0	174	31	19.1	- 2.0	Doubtful
IST	78.7	321	24.5	28.7	+41.8	Doubtful
KIP	46.3	109	34	33.9	-24.4	Doubtful
LON	53.5	58	32	44.3	-51.9	Doubtful
MAN	43.7	231	35	37.4	+23.6	Near

May 22, 13^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
MBC	42.5	21	35.5	-58.0	- 0.1	Near
NDI	61.1	282	30	3.5	-17.2	Good
NUR	64.0	335	29	-20.4	+ 2.6	Good
PMG	58.1	189	31	-12.9	-26.6	Doubtful
PNT	55.3	55	32	-44.3	+37.8	Good
RAB	52.6	183	32.5	13.6	- 0.9	Doubtful
SCH	71.2	24	27	-57.0	+ 8.5	Doubtful
SEO	22.9	252	44.5	37.4	- 3.8	Near
SHI	75.8	299	25.5	-11.8	-17.1	Good
SHL	53.5	268	32	31.6	+ 3.2	Good
STU	78.5	337	25	-48.2	-21.5	Good
TUC	69.3	65	27.5	26.2	-48.7	Doubtful

June 24, 04^h, 59.5N, 151.7W, Cook Inlet (Tentative Solution)

P Wave Data:

Compressions:	AAM	ALQ?	BEO	BKS	COR	DAL	FLO	GEO	GOL
HAK	HAL	HNR	LIS	LPS	MHC	MHT	MNT	NEM	PAL	PMG
RAB	ROL	SCB	SLM	SHS	TUC	VIC.				
Rarefactions:	ALE	ABJ	ASA	ATU	BAG	BHP	CAR	CLS	COP
DBN	GOT	GRC	HKC	JER	KEV	KLS	KSA	KUS	LJU	LND
MAE	MAN	MAT	MES	NGS	NUR	OTT	PAS	PLM	PNT	ROM
SCH	STR	STU	TOL	UME	UPP.					

S Wave Data: $\delta\bar{\epsilon} = 25.6$ $S_{\bar{\epsilon}} = 32.2$ N = 21

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	44.1	82	35.5	90.0	+ [illegible].0	Good
BAG	74.9	277	26.5	50.9	-44.3	Doubtful
BHP	73.3	101	27	90.0	+20.2	Doubtful
BLO	45.0	87	35.5	69.4	-16.0	Good
COP	64.5	10	29.5	34.2	+24.3	Good
COR	22.7	118	45	54.2	- 4.7	Near
DAL	44.7	102	36	90.0	+18.8	Near
GEO	50.0	79	34	90.0	- 2.8	Doubtful
GOL	35.0	103	38.5	59.2	-12.0	Near
HAL	52.1	65	33	-44.0	+29.4	Good
HNR	78.8	229	25	26.7	-63.3	Doubtful
KEV	51.0	1	33.5	68.7	+32.0	Doubtful
LPS	63.9	107	30	57.4	- 6.5	Doubtful

June 24, 04^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
MAN	76.1	275	26	68.0	-26.1	Good
[illegible]	46.7	71	35	-38.3	+41.4	Good
CTT	45.8	73	35.5	-34.3	+47.4	Good
RAB	77.2	238	25.5	90.0	+ 3.5	Doubtful
ROL	43.2	92	35.5	-60.2	+39.0	Doubtful
SCB	45.3	77	35	-68.4	+17.0	Doubtful
SCH	43.4	57	35.5	90.0	-24.2	Near
STU	71.0	13	27.5	65.5	+63.7	Doubtful

June 26, 17^h, 7.1N, 82.3W, South Coast Panama

P. Wave Data:

Compressions: AAM ALQ ARE BKS BLO CLS COR DAL FAY GEO GOL GSC LND LPA LPB LPS MNT OTT? PAS PNT RCD RES ROL SHS SKA STR UPP VIC.

Rarefactions: CAR MAL PDA PRI PTO TOL TRN.

S Wave Data $\delta\bar{\epsilon}$ = 15.3 S_ϵ = 18.6 N = 21

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
ALQ	35.5	325	37	-30.[illegible]	-15.3	Near
ARE	25.7	15[illegible]	40.5	-17.1	+30.9	Near
BKS	47.4	316	33.5	-10.9	-19.4	Doubtful
COR	51.6	323	32.5	5.9	+14.2	Doubtful
DAL	28.9	334	38.5	-28.7	+ 9.1	Near
GEO	32.0	8	37.5	-76.2	+20.5	Near
GOL	38.5	331	36.5	-39.8	-10.3	Near
GSC	42.2	316	35.5	7.3	- 1.1	Near
LND	35.8	1	37	-86.2	- 0.2	Near
LPA	47.7	153	33.5	-16.0	+26.1	Good
LPB	27.4	149	39.5	-28.4	+ 4.6	Near
MBC	72.0	[illegible]51	27	-70.0	- 6.7	Good
OTT	38.6	7	36.5	-70.4	+24.6	Near
PDA	59.5	50	30.5	0	- 8.4	Good
PNT	52.5	330	32.5	-61.1	+36.3	Doubtful
PTO	73.1	49	26.5	28.3	+15.4	Good
RCD	41.1	337	35.5	-25.2	+17.1	Near
RES	67.9	356	28	-84.3	-11.6	Good
TOL	76.5	51	25	7.3	- 2.5	Good

June 26, 17^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
TRN	20.9	79	50	90.0	-21.4	Near
VIC	53.9	327	32	-43.3	-25.8	Good

June 28, 21^h, 46.5N, 153.2E, Kurile Islands

P Wave Data:

Compressions: AAM ADE ALE ALQ ATU BAG BEO BLO CHA CTA DAL DBN DBQ FKK GOL HAL HIR HKC HMD IST IZU KEV KEW KIR KJN KOC KRL KSA LJU LON MAE MAN MAT MBC MHT MNT MUN NDI NGS NHA NUR OIT OTT PAV PBA PMG PNT POO RES RIV? ROL ROM SCB SEO SHI SHL STR STU TOL UME VIC.

Rarefactions: AFI BKS CLS COR GUA HNR KIP MHC PRI RAB SHS TUC.

S Wave Data: $\delta\bar{\epsilon}$ = 20.2° S_ϵ = 27.7° N = 31

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	78.2	39	25	69.2	- 1.2	Doubtful
BLO	79.4	43	24.5	71.4	+ 3.3	Good
COR	55.8	59	31.5	57.0	- 4.2	Good
CTA	66.6	187	28.5	-66.4	- 0.7	Good
DAL	79.0	54	24.5	58.6	- 2.5	Good
DBQ	74.8	43	26	64.7	- 3.4	Good
GOL	69.2	54	27.5	46.6	-15.5	Doubtful
GUA	33.5	195	38	-27.1	+44.6	Near
HKC	39.7	246	36.5	62.2	-28.3	Near
HNR	56.0	172	31.5	-63.5	- 8.8	Doubtful
IST	79.7	321	24.5	-77.9	-13.6	Doubtful
KEV	57.6	341	31	59.3	-23.9	Doubtful
KIP	46.6	105	34	0.0	-23.1	Good
LON	55.5	56	31.5	1.7	-61.1	Good
LND	78.9	37	24.5	63.9	- 7.7	Good
MAN	41.6	231	36	-40.9	+46.0	Near
MNT	79.5	31	24.5	68.2	- 6.7	Doubtful
NDI	60.5	282	30	36.0	+17.6	Good
NHA	50.4	242	33	79.3	- 4.5	Doubtful
NUR	65.5	335	29	15.9	-76.4	Doubtful
PMG	55.9	187	31.5	87.6	-26.3	Doubtful

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
PNT	55.3	53	31.5	50.6	-13.7	Doubtful
RAB	50.5	181	33	-15 2	-46.9	Doubtful
RES	51.1	18	33	-84.0	-21.3	Doubtful
RIV	80.0	182	24.5	-65.0	- 3.6	Good
SCB	78.9	36	24.5	81.2	+ 9.0	Doubtful
SCH	73.6	23	26.5	64.6	-13.4	Doubtful
SHI	75.9	298	25.5	1.8	-26.0	Doubtful
STU	80.1	337	24.5	71.4	-34.1	Good
TUC	71.2	63	27	66.7	-10.6	Good
VIC	53.6	55	32	86.5	+22.9	Good

August 3, 10^h, 7.7N, 35.8W, Mid-Atlantic

P Wave Data:

Compressions: AAE ALG ANT AQU ARE ATU BEO BUL COP
GOT IST KIR KJN KLS KON LIS LJU LPA LPB MAL
NAI NNA NUR OTT PNT PRE QUI SFA SKA SOD STU
TAM TOL UME UPP VAL VIC WIN ZAG.

Rarefactions: AAM ALQ ATL BEC BHP BKS BLA BOG CAR
COR DAL DBQ DUG FLO GDH GEO GOL GSC HAL LND
LON LPS MBC MDS MNT RCD RES SCP SHA SJP TRN
TUC TUL.

S Wave Data: $\delta\bar{\epsilon}$ = 16.1 S_ϵ = 20.9 N = 27

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	54.4	317	32	0	4.5	Good
BLA	50.0	313	33.5	- 7.5	+22.3	Doubtful
DAL	61.5	303	30	34.1	+ 0.4	Good
DBQ	59.3	315	30.5	-10.4	+18.3	Good
DUG	75.2	309	26	17.2	+ 0.6	Doubtful
GDH	52.6	353	29.5	-84.3	+20.2	Good
GEO	48.4	316	34	0	+ 8.2	Good
GOL	69.4	309	27.5	21.6	+ 3.4	Good
GSC	78.3	304	25	21.0	+ 4.7	Good
HAL	44.0	331	35	-27.1	+ 2.1	Near
IST	66.0	49	28.5	35.4	+11.7	Doubtful
KON	62.1	24	30	90	+20.2	Doubtful
LND	53.1	319	32.5	-28.7	+29.1	Good
LPS	52.7	282	32.5	38.2	+39.9	Good

August 3, 10^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
MAL	40.6	40	36	0	+44.7	Near
MDS	58.9	316	30.5	-25.5	+31.2	Doubtful
NAI	72.9	94	26.5	-69.0	+ 1.6	Good
NUR	69.1	27	27.5	53.8	+10.2	Good
OTT	50.9	324	33	-24.9	+14.4	Doubtful
PRE	70.5	121	27	32.9	+35.0	Doubtful
RES	74.7	346	26	-56.2	+ 2.9	Good
SCB	52.2	321	32.5	-38.2	+34.1	Doubtful
SCH	53.1	338	32.5	-27.8	+11.1	Doubtful
SCP	49.8	318	33.5	-18.6	+21.9	Good
SJP	31.3	293	38.5	41.0	+22.4	Near
TOL	42.8	37	35.5	38.2	+12.0	Near
TUC	73.3	301	26.5	25.4	+ 8.3	Good

August 15, 17^h, 13.8S, 69.3W, Peru-Bolivia Border

P Wave Data:

Compressions: BHA BHP BOG BUL CAR DAL LPA MHC PAS? PRI SHA.

Rarefactions: ALQ BEC BKS CLS COR DBQ DUG GEO GOL LJU LON LUB LWI MAL MDS MHT PTO RCD ROL ROM SCP SHS SPA STR TAM TOL TRN TUC.

S Wave Data: $\delta\bar{\epsilon}$ = 6.6 S_ϵ = 8.6 N = 8

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	57.4	347	43	-52.8	-10.7	Good
DBQ	59.4	342	42.5	-41.3	+ 0	Good
GOL	62.9	329	40.5	-26.3	+14.8	Good
LON	76.4	326	34.5	-60.5	- 4.9	Good
MHT	58.6	335	43	-42.1	- 4.0	Good
PTO	78.2	42	34	-25.6	+ 1.3	Good
ROL	55.6	338	44	-45.8	- 8.4	Good
SCP	54.9	352	44.5	-33.6	+ 7.8	Good

August 15, 17^h, 13.8S, 69.3W, Peru-Bolivia Border (Alternate Solution)

P Wave Data:

Compressions: BHA BHP BOG BUL DAL LPA MHC PAS? PRI SHA. CAR

August 15, 17^h, (Alternate Solution) Continued

P Wave Data Continued:

Rarefactions: ALQ BEC BKS CLS COR DBQ DUG GEO GOL LJU LON LUB LWI MAL MDS MHT PTO RCD ROL ROM SCP SHS SPA STR TAM TOL TRN TUC.

S Wave Data: $\delta\bar{\epsilon}$ = 9.6 S_ϵ = 13.1   N = 8

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	57.4	347	43	-52.8	+11.9	Good
DBQ	59.4	342	42.5	-41.3	+ 5.2	Good
GOL	62.9	329	40.5	-26.3	+24.5	Good
LON	76.4	326	34.5	-60.5	-16.8	Good
MHT	58.6	335	43	-42.1	+10.3	Good
PTO	78.2	42	34	-25.6	- 1.8	Good
ROL	55.6	338	44	-45.8	+ 6.0	Good
SCP	54.9	352	44.5	-33.6	- 0.5	Good

August 29, 15^h, 7.1S, 81.6W, Coast of Peru

P Wave Data:

Compressions: BHP BOG CAR CHN GAL TRN.

Rarefactions: AAM AFI ALG BEC BKS BLO CLS COR DAL GOL LIS LON LPA LPS MAL MHC PDA PRI ROM ROL SHS STR TAM TOL TUC TUL UME.

S Wave Data: $\delta\bar{\epsilon}$ = 17.2 S_ϵ = 24.9   N = 7

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
BKS	58.6	323	30.5	-25.5	-49.8	Doubtful
BLO	46.3	355	34	32.0	- 5.5	Good
COR	63.7	328	29.5	23.0	- 5.5	Good
DAL	42.3	341	35.5	11.5	-19.2	Good
PDA	68.5	45	28	0.0	-17.3	Doubtful
ROL	45.8	349	34	13.4	-22.3	Good
TRN	26.7	49	40	20.5	+ 0.4	Good

September 4, 13^h, 71.4N, 73.3W, Near East Coast of Baffin Island   (Tentative Solution)

P Wave Data:

Compressions: AAM ATU BHP BLO BOZ CAR DAL GEO GOL KEW KSA LJU LON LPS PDA ROL SHA SHS? TRN ZAG.

Rarefactions: AQU BKS BOG CLS COP COR JER KEV KIP? KIR MAL MHC NUR PRI SEO SHI STR STU TOL TUL UME UPP.

September 4, 13^h, Continued

S Wave Data: $\delta\bar{\epsilon} = 29.2$ $S_\epsilon = 36.4$ N = 21

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
ATU	56.7	70	31.5	-76.0	+ 9.7	Good
AQU	49.5	77	33.5	-72.2	+20.5	Good
BKS	41.8	244	35.5	9.0	+18.9	Near
BLO	33.0	199	38	0	+38.6	Near
BOZ	31.4	235	38	11.1	+66.2	Near
CAR	61.0	173	30	52.1	+30.4	Good
COP	37.4	68	37	-54.1	+28.5	Near
COR	35.9	249	37	15.4	+40.1	Near
DAL	40.6	211	36	10.6	+17.0	Near
KEV	29.8	44	38.5	-12.6	+45.2	Near
LON	33.5	249	38	59.4	+89.9	Near
LPS	57.9	198	31	26.3	+24.7	Good
MAL	48.9	96	33.5	68.7	+ 4.3	Doubtful
NUR	36.8	55	37	-49.8	+19.8	Near
ROL	34.9	206	37.5	0	+31.1	Near
SEO	70.4	343	27	70.0	+41.3	Doubtful
SHA	41.6	199	35.5	14.0	+28.1	Near
SHI	72.4	48	26.5	-61.4	+ 0.4	Doubtful
STU	42.5	76	35.5	-58.0	+33.1	Near
TOL	46.2	94	34.5	70.8	+ 3.1	Doubtful
TRN	61.1	167	30	69.4	+21.5	Good

September 4, 13^h, Continued

P Wave Data:

Compressions: (As above)

Rarefactions: AQU BKS BOG CLS COP COR JER KIP? MAL
MHC NUR PRI SEO SHI STR STU TOL TUL UME UPP

(Plus others as above).

S Wave Data: $\delta\bar{\epsilon} = 19.5$ $S_\epsilon = 24.5$ N = 21

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
ATU	56.7	70	31.5	-76.0	+15.0	Good
AQU	49.5	77	33.5	-72.2	+ 7.6	Good
BKS	41.8	244	35.5	9.0	+15.2	Near
BLO	33.0	199	38	0	+26.1	Near
BOZ	31.4	235	38	11.1	+26.2	Near
CAR	61.0	173	30	52.1	+ 3.7	Good
COP	37.4	68	37	-54.1	+ 4.3	Near

September 4, 13^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
COR	35.9	249	37	15.4	+ 8.1	Near
DAL	40.6	211	36	10.6	+14.2	Near
KEV	29.8	44	38.5	-12.6	+29.3	Near
LON	33.5	249	38	59.4	+37.6	Near
LPS	57.9	198	31	26.3	+10.6	Good
MAL	48.9	96	33.5	68.7	+37.7	Doubtful
NUR	36.8	55	37	-49.8	+ 0.3	Near
ROL	34.9	206	37.5	0	+24.3	Near
SEO	70.4	343	27	70.0	+56.1	Doubtful
SHA	41.6	199	35.5	14.0	+15.2	Near
SHI	72.4	48	26.5	-61.4	+15.8	Doubtful
STU	42.5	76	35.5	-58.0	+ 5.3	Near
TOL	46.2	94	34.5	70.8	+37.3	Doubtful
TRN	61.1	167	30	69.4	+19.0	Good

September 17, 05^h, 10.6S, 78.2W, Central Peru (Alternate Solution)

P Wave Data:

Compressions: BOG CAR SAN? TRN.

Rarefactions: AAM BEC BHP BKS BLO CLA COR DAL GAL GEO GOL LON LPA LPS MAL MHC PAS PRI TOL TUL SCP SEA SHA SHS

S Wave Data: $\delta\bar{\epsilon} = 16.7$ $S_\epsilon = 19.7$ N = 11

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	52.9	355	33	14.4	-22.2	Good
BEC	44.6	16	35.5	9.C	-18.2	Good
BKS	63.4	322	30	36.0	+ 4.3	Good
BLO	50.1	352	34	27.4	- 9.9	Doubtful
DAL	46.7	338	35	0	-37.5	Good
DBQ	54.1	349	32.5	28.7	- 9.3	Doubtful
GEO	49.3	1	34	14.2	-20.3	Good
GOL	56.0	335	32	26.1	-11.7	Doubtful
LPA	30.4	146	39	10.2	+22.0	Doubtful
LPS	27.0	336	40	19.7	-16.4	Near
TRN	26.9	39	40	0	-11.8	Near

September 17, 05^h, Continued

P Wave Data:

Compressions: CAR TRN and others (see alternate solution tabulation)

September 17, 05^h, Continued

P Wave Data Continued:

Rarefactions: LPA and others.

S Wave Data: $\delta\bar{\epsilon}$ = 5.1 S_ϵ = 8.5 N = 11

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	52.9	355	33	14.4	- 2.0	Good
BEC	44.6	16	35.5	9.0	+ 1.4	Good
BKS	63.4	322	30	36.0	+ 6.3	Good
BLO	50.1	352	34	27.4	+10.7	Doubtful
DAL	46.7	338	35	0	-21.4	Good
DBQ	54.1	349	32.5	28.7	+ 9.7	Doubtful
GEO	49.3	1	34	14.2	+ 0.8	Good
GOL	56.0	335	32	26.1	+ 1.6	Doubtful
LPA	30.4	146	39	10.2	- 0.2	Doubtful
LPS	27.0	336	40	19.7	- 0.1	Near
TRN	26.9	39	40	0	- 2.0	Near

September 24, 16^h, 10.6S, 78.0W, Coast of Peru

P Wave Data:

Compressions: BEC BHP BOG CAR CHN CLS LJU LPS MAL MDS MHT PDA RCD ROL SAN? SCP SEA SHS SKA TOL TRN TUL UPP.

Rarefactions: ALQ BKS BOZ COR DAL DUG GOL GSC LPA LPB LOB MHC PRI ROM TUC

S Wave Data: $\delta\bar{\epsilon}$ = 14.8 S_ϵ = 21.4 N = 8

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
BEC	44.6	16	35.5	37.2	-29.7	Doubtful
COR	68.5	327	28.5	-59.9	+ 0.8	Good
DAL	46.8	338	34.5	-37.5	+34.5	Good
GOL	56.1	335	32	-62.3	+ 6.8	Good
MHT	52.5	342	33	-87.6	-11.2	Good
PDA	68.6	42	28.5	18.6	+ 4.9	Good
ROL	50.0	346	34	-80.4	- 0.1	Good
SCP	51.1	0	33.5	54.2	-30.6	Good

September 24, 16^h, Continued

P Wave Data:

Compressions: CLS LPS SAN? SEA SHS and others.

Rarefactions: DAL and others.

September 24, 16^h, Continued

S Wave Data: $\delta\bar{\varepsilon}$ = 16.9 S_ε = 21.7 N = 8

Sta.	Δ	Az	i_o	ε_o	$\varepsilon_o-\varepsilon_c$	Grade
BEC	44.6	16	35.5	37.2	- 4.1	Doubtful
COR	68.5	327	28.5	-59.9	-24.5	Good
DAL	46.8	338	34.5	-37.5	+21.7	Good
GOL	56.1	335	32	-62.3	- 8.1	Good
MHT	52.5	342	33	-87.6	-17.5	Good
PDA	68.6	42	28.5	18.6	+39.1	Good
ROL	50.0	346	34	-80.4	- 2.5	Good
SCP	51.1	0	33.5	54.2	-17.8	Good

October 3, 23^h, 32.2N, 131.6E, Kyushu, Japan (Tentative Solution)

P Wave Data:

Compressions: ATU BAG COP HKC KEV KSA MAN NUR PRA PRU SHI SHL STR TOL.

Rarefactions: ADE BKS CAN CLS HNR MHC PRI RAB UPP.

S Wave Data: $\delta\bar{\varepsilon}$ = 17.4 S_ε = 24.7 N = 3

Sta.	Δ	Az	i_o	ε_o	$\varepsilon_o-\varepsilon_c$	Grade
COP	78.3	330	25	-34.3	+18.3	Doubtful
NUR	70.2	330	27.5	-49.6	+ 4.6	Good
SHL	35.3	270	37.5	54.0	-29.3	Near

October 12, 11^h, 44.8N, 149.0E, Kurile Islands

P Wave Data:

Compressions: ADE ALE ALQ ATU BAG BKS BOZ CAN CHG COP COR CTA DBN DUG GDH GOL GRC HAL HKC HVO IST KEV KEW KON KRL KSA LJU LND MAN MBC NDI NHA NUR PAD PAV PCU PRU PRI RCD RES ROM SCB SCO SHI SHL? SLC STR STU TAP TOL TUC TUL VIC ZAG.

Rarefactions: AFI ALE GSC KJN LON MHC PMG RAB.

S Wave Data: $\delta\bar{\varepsilon}$ = 14.8 S_ε = 19.5 N = 27

Sta.	Δ	Az	i_o	ε_o	$\varepsilon_o-\varepsilon_c$	Grade
ADE	79.9	189	24.5	-61.8	- 0.3	Good
AFI	68.4	139	28	18.7	+36.7	Good
ALQ	75.3	55	26	59.4	- 1.7	Good
BAG	37.0	229	37	-78.8	- 5.4	Near
BKS	63.8	62	29	42.2	-14.8	Doubtful
CHG	48.8	255	33.5	67.6	-35.6	Doubtful
COP	73.4	336	26.5	-44.8	+34.4	Doubtful

October 12, 11^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o-\epsilon_c$	Grade
CCR	59.2	56	30.5	50.9	-10.3	Good
CTA	64.6	183	29	-45.2	+12.5	Good
GDH	65.1	9	29	68.5	-13.0	Doubtful
GOL	72.6	51	26.5	58.2	- 5.5	Good
GSC	68.9	61	27.5	42.6	-14.7	Good
GUA	31.3	188	38.5	90.0	-26.5	Near
HKC	36.3	243	37.5	-77.5	- 8.2	Near
HNR	54.9	167	32	-38.3	+ 8.3	Good
KEV	58.2	340	31	-74.9	+26.7	Doubtful
KIP	49.1	100	33.5	31.2	+ 4.0	Doubtful
MAN	38.2	227	37	83.7	-22.9	Near
MBC	47.4	19	34	76.8	+ 3.7	Good
NDI	57.9	280	31	70.4	-30.2	Doubtful
NUR	65.7	333	29	-40.3	+40.7	Good
RAB	48.9	176	33.5	-42.8	+11.4	Good
RCD	70.7	47	27	52.9	-13.3	Good
RIV	78.3	178	25	-52.3	+ 0.8	Good
SCO	64.8	357	29	-82.0	+13.4	Doubtful
SHI	74.0	296	26	10.8	- 0.4	Good
TUC	74.6	60	26	62.6	+ 4.9	Good

October 13, 05^h, 44.8N, 149.5E, Kurile Islands

P Wave Data:

Compressions: AAM ADE ALQ ANP AQU ATU BAG BEO BHP BKS BLA CHG COR CTA DAL DBN DUG GDH GEO GOL GSC IST KEV KEW KON KRL KSA LAH LJH LND LON MAN MHC MNT MUN NDI NUR OXF PAV PMG PRI PRU QUE RCD RIV ROM SCB SCH SCO SCP SHA SHI SHL STR STU TAP TRI TOL TUC TOL UME WES ZAG.

Rarefactions: AFI CLS GUA HKC? HNR KIP RAB TAU.

S Wave Data: $\delta\bar{\epsilon} = 20.0$ $S_\epsilon = 25.4$ N = 6

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o-\epsilon_c$	Grade
ALQ	75.0	56	26.5	22.6	-29.5	Doubtful
BKS	63.5	62	30	22.0	-28.8	Doubtful
CTA	64.6	183	29.5	-41.0	+ 4.2	Doubtful
PMG	54.0	183	32.5	-48.2	- 2.9	Doubtful
RIV	78.3	179	25	-68.1	-26.0	Doubtful
TUC	74.2	60	26.5	22.6	-28.6	Doubtful

October 20, 00^h, 44.7N, 150.7E, Kurile Islands

P Wave Data:

Compressions: AAM AQU ATU BAG BKS CHG COP GDH GEO HAL HKC IST KEV KRL LAH LJU LND MBC MHC MNN MNT NDI NHA NUR OTT PAR PAV PRI QUE RCD RES ROM SCB SCP SEO SHA SHI SHL SHS STR STU TOL TRI WES.

Rarefactions: ADE ALQ BOZ? COR CLS CTA GOL GSC GUA HNR KIP MUN OXF PMG RAB RIV VIC?.

S Wave Data: $\delta\bar{\varepsilon}$ = 22.6 S_ε = 33.6 N = 15

Sta.	Δ	Az	i_o	ε_o	$\varepsilon_o - \varepsilon_c$	Grade
ADE	80.0	190	24.5	-46.3	+17.5	Good
CHG	50.0	256	33.5	-25.7	+82.1	Doubtful
COP	58.3	37	31	68.1	-11.6	Good
DBQ	77.3	42	25	87.8	+ 0.4	Good
GDH	65.0	9	29	-34.3	+39.5	Doubtful
GOL	71.7	52	27	84.4	+ 3.1	Good
HKC	37.3	245	37	67.9	-14.2	Near
HNR	54.5	169	32	-45.3	+ 5.2	Doubtful
IST	79.9	319	24.5	44.3	+59.8	Good
KEV	58.7	340	31	-25.4	+28.2	Good
NDI	59.2	281	30.5	31.1	-13.4	Doubtful
RCD	69.9	48	27.5	82.1	- 1.7	Good
RIV	78.2	180	25	-47.2	+ 7.8	Good
SHI	75.1	297	26	8.1	- 9.0	Good
TUC	73.5	61	26.5	29.2	-46.0	Good

October 20, 00^h, Continued

P Wave Data:

Compressions: AAM AQU ATU BAG BKS CHG COP GDH GEO HAL HKC IST KEV KRL LAH LJU LND MBC MHC MNN MNT NDI NHA NUR OTT PAR PAV PRI QUE RCD RES ROM SCB SCP SEO SHA SHI SHL SHS STR STU TOL TRI WES.

Rarefactions: ADE ALQ BOZ? COR CLS CTA GOL GSC GUA HNR KIP MUN OXF PMG RAB RIV VIC.

S Wave Data: $\delta\bar{\varepsilon}$ = 18.2 S_ε = 30.0 N = 15

Sta.	Δ	Az	i_o	ε_o	$\varepsilon_o - \varepsilon_c$	Grade
ADE	80.0	190	24.5	-46.3	+12.1	Good
CHG	50.0	256	33.5	-25.7	-88.2	Doubtful

October 20, 00^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
COR	58.3	57	31	68.1	-10.7	Good
DBQ	77.3	42	25	87.8	- 4.0	Good
GDH	65.0	9	29	-34.3	+24.2	Doubtful
GOL	71.7	52	27	84.4	+ 1.5	Good
HKC	37.3	245	37	67.9	- 5.1	Near
HNR	54.5	169	32	-45.3	+ 5.8	Doubtful
IST	79.9	319	24.5	44.3	+49.8	Good
KEV	58.7	340	31	-25.4	+ 4.2	Good
NDI	59.2	281	30.5	31.1	- 5.9	Doubtful
RCD	69.9	48	27.5	82.1	- 4.3	Good
RIV	78.2	180	25	-47.2	+ 1.6	Good
SHI	75.1	297	26	8.1	-10.7	Good
TUC	73.5	61	26.5	29.2	-45.5	Good

November 3, 03^h, 3.5S, 77.8W, Peru, Ecuador (Tentative Solution)

P Wave Data:

Compressions: AAM ALQ ANT ATU BHP BKS BOZ CAR COR
DAL DBN FLO GDH GEO GOL KEW LPA LPS LWI MAL
OGD OXF PAS PAV PDA PLM PRI PTO RCD ROM SAN
SCP STR TOL TUC VLN.

Rarefactions: ATL? CLS BLA? KON MHC SHA TRN TRO TUL.

S Wave Data: $\delta\bar{\epsilon}$ = 24.5 S_ϵ = 32.7 N = 18

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	45.9	354	34.5	0	-21.9	Good
ALQ	46.8	327	34	35.8	- 8.7	Good
BOZ	57.2	333	31	22.7	+16.6	Doubtful
DAL	40.4	335	36	6.5	-31.2	Near
GDH	74.5	9	26	29.3	+16.2	Good
GOL	49.9	332	33.5	37.9	- 2.9	Good
LPA	36.3	152	37	-20.4	-11.5	Near
MAL	78.9	52	24.5	0	+15.0	Good
OXF	39.4	345	36.5	30.3	+ 1.0	Near
PDA	63.3	44	29.5	- 8.7	+ 6.7	Good
PTO	76.8	46	25.5	15.4	+28.4	Good
RCD	52.6	37	32.5	90.0	+52.9	Good
SCP	44.1	0	35	0	-16.3	Good

November 3, 03^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
SHA	35.4	345	37.5	77.5	+48.4	Near
TOL	79.9	49	24.5	0	+13.6	Good
TRN	21.5	49	47	0	+40.5	Near
TUC	47.4	321	34	-34.8	-83.8	Good
VLN	79.1	36	24.5	19.3	+25.4	Good

November 9, 21^h, 9.0S, 71.5W, Western Brazil

P Wave Data:

Compressions: ANT BEO FUQ KEW KON LPA ROM SAN TRN TUL.

Rarefactions: AAM ATL ATU BHI BKS BLA BLO BOZ CAR CLS DAL? DBQ DUG FLO GDH GEO GOL LON LPS MAL MDS MHC MHT MNN OGD OXF PDA PLM PRI PTO ROL SCP SHA SHS SLM STR TOL TRO TUC.

S Wave Data: $\delta\bar{\epsilon} = 8.5°$ $S_\epsilon = 10.2°$ N = 12

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
BLO	49.9	345	49	+ 9.3	- 3.5	Good
BOZ	65.0	330	42	5.2	+14.4	Good
DBQ	54.2	343	46.5	+ 2.1	- 8.8	Good
GDH	79.1	6	35.5	21.6	- 9.2	Good
MAL	77.5	49	36	+13.1	-11.1	Good
MHT	53.3	336	46.5	+ 1.4	- 3.7	Good
PDA	63.2	40	43	21.2	+ 7.0	Good
PLM	60.3	317	44	-39.6	- [illegible]	Good
PTO	76.2	44	36.5	+ 5.2	-18.6	Good
ROL	50.4	339	49	+ 6.6	- 2.8	Good
SLM	50.5	341	49	+ 8.6	- 2.1	Good
TOL	78.9	46	35.5	+13.1	-11.5	Good

November 10, 01^h, 9.2S, 71.5W, Western Brazil

P Wave Data:

Compressions: ANT DAL FUQ SAN STR TRI.

Rarefactions: AAM ATL BHP BKS BLA BOZ CAR CLS COR FLO GEO GDH GOL KON LON LPA LPS LWI MAL MHC OGD PTO PRI RCD SCP SEA SHA? SHS TOL TRN TUC.

S Wave Data: $\delta\bar{\epsilon} = 10.0$ $S_\epsilon = 13.7$ N = 12

Sta:	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	52.4	349	48	-23.5	-25.7	Good

November 10, 01^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
BOZ	65.1	331	42	-37.6	- 8.1	Good
GDH	79.3	6	35	- 4.9	- 9.6	Good
GOL	57.9	329	45.5	-22.0	+ 6.0	Good
LON	71.4	326	39	-60.2	-20.8	Good
LPS	29.2	323	60.5	-19.7	+ 4.8	Near
MAL	77.6	49	36	7.3	- 1.3	Good
PDA	63.4	40	42.5	4.4	- 4.5	Good
PLM	60.4	317	44	-37.6	+ 5.1	Good
PTO	76.4	44	36.5	11.3	+ 2.1	Good
TOL	79.1	46	35.5	-16.5	-25.8	Good
TRN	22.1	27	66	8.9	- 6.3	Near
(LPA	28.4	156	60.5	-34.1	-88.0	Near)

November 15, 21^h. 44.3N, 149.0E, Kurile Islands

P Wave Data:

Compressions: ALQ ATU BKS BOZ COP COR GOH GOL GRC GSC KEV KJN KON NOR NUR PRI RCD ROM SCO STR TAP ZAG?

Rarefactions: ADE AFI BAG CAN CHG CLS CTA GOT GUA HKC HNR IST JER KIP KRL MAN MHC NDI NHA PMG RAB RIV SHI SHL TOO TUC TUL UPP.

S Wave Data: $\delta\bar{\epsilon} = 23.8$ $S_\epsilon = 32.0$ N = 26

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AFI	68.0	139	28.5	59.9	-20.6	Doubtful
ALQ	75.6	55	26	-37.0	+15.4	Doubtful
BAG	36.7	230	37.5	55.1	- 9.1	Near
BKS	64.0	62	30	-68.3	- 9.6	Doubtful
BOZ	65.9	49	29	-84.3	-35.7	Doubtful
CHG	48.7	255	34.5	28.2	-47.5	Doubtful
COP	73.8	336	26.5	0.0	-31.5	Doubtful
COR	59.5	56	31	-71.5	-16.3	Doubtful
CTA	64.1	183	30	-10.4	+37.2	Good
GOL	72.9	51	27	-37.8	+11.7	Doubtful
GSC	69.2	61	28	-15.1	+42.4	Doubtful
GUA	30.8	188	39	+ 7.8	- 6.7	Near
HKC	36.1	244	38	47.3	-21.7	Near
HNR	54.4	167	32	- 7.6	+68.5	Good

November 15, 21^h, Continued

S Wave Data Continued:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
IST	79.4	318	25	-39.2	-82.4	Good
KIP	49.0	100	33.5	-48.9	+28.2	Doubtful
NHA	46.7	239	35	36.2	-41.8	Good
NOR	54.1	357	32.5	0.0	- 5.6	Good
NUR	66.1	333	29	32.4	+ 1.3	Good
PMG	53.5	182	32.5	-11.0	-41.5	Good
RAB	48.4	176	34.5	- 3.3	+ 5.8	Doubtful
RIV	77.8	178	25.5	- 1.8	- 5.5	Doubtful
SCO	65.3	357	29.5	- 8.7	-13.9	Doubtful
SHI	74.2	296	26.5	57.2	- 3.5	Doubtful
SHL	49.4	267	33.5	61.9	-12.4	Good
TUC	74.8	60	26.5	-58.2	- 1.8	Good

November 17, 00^h, 7.6N, 37.4W, North Atlantic Ocean

P Wave Data:

Compressions: ANT ARE ATU BHP BOG? BUL CAR CHN CLS
COP GOT HLW IST KEV KIR KON LJN LPA LPB MAL
NUR PTO QUI SAN SKA STU TOL TRI TRN TUC UME
UPP VAL ZAG.

Rarefactions: AAM ALQ ATL AQU? BEO BKS BLA DAL FLO
FUQ GDH GEO GOL GSC KIM LWI MHC NAI OGD PAR
PRE PRI RCD SCO? SCP SHS SLM TRO TUL WIN.

S Wave Data: $\delta\epsilon$ = 17.6 S_ϵ = 20.7 N = 26

Sta	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	53.4	318	32	-12.8	+27.8	Good
ALQ	68.5	305	28	21.5	+19.8	Good
ARE	41.3	235	36	-10.6	+17.8	Near
ATE	62.7	51	29.5	-45.0	+14.5	Doubtful
BOG	36.6	268	37.5	86.2	+ 4.2	Near
CAR	29.3	278	38.5	81.1	+ 4.6	Near
COP	61.9	29	30	37.9	+ 3.7	Good
FLO	56.7	312	31.5	3.4	+23.3	Good
GDH	62.5	354	29.5	-84.3	+24.9	Good
GOL	68.3	310	28	16.0	+16.8	Good
HLW	67.0	61	28.5	-43.3	+13.9	Good
LPA	46.5	203	34.5	38.5	+11.5	Good

November 17, 00^h, Continued

S Wave Data:

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
LPB	38.7	232	36.5	0	+21.0	Near
MAL	41.7	41	36	0	+ 0.4	Near
NAI	74.5	93	26	18.1	+32.3	Good
NOR	74.6	3	26	-88.9	+15.8	Good
NUR	69.9	28	27.5	43.6	+ 5.4	Good
PRE	71.8	120	27	41.7	+43.8	Good
PTO	42.1	33	36	14.7	+ 7.8	Near
QUI	41.7	261	36	75.3	+26.2	Near
RCD	67.4	315	28	0	+24.0	Good
SCP	48.9	319	33.5	- 3.3	+15.1	Good
STU	56.7	35	31.5	0	+16.6	Doubtful
TOL	43.9	38	35	0	+ 8.6	Near
VAL	49.5	22	33.5	24.8	+27.0	Good
WIN	61.2	121	30	29.4	+30.3	Good

November 18, 14^h, 29.9N, 113.6W, Gulf of California (No Solution)

P Wave Data:

Compressions: ATL CLS BKS GEO GOT MHC OGD SCP SHA SHS STR TRN TUL UME UPP.

Rarefactions: AAM ANT ARE BHP BOG CAR LPS LPB PAS PRI QUI SCO.

S Wave Data: $\delta\bar{\epsilon}$ = 24.5 S_ϵ = 30.2 N = 10

Sta.	Δ	Az	i_o	ϵ_o	$\epsilon_o - \epsilon_c$	Grade
AAM	27.0	55	39.5	63.6		Near
ANT	67.5	137	28	48.5		Doubtful
BOG	45.0	116	34.5	-32.8		Good
KIP	40.7	269	35.5	40.1		Near
KON	79.3	26	24.5	90.0		Doubtful
LPB	63.7	130	29.5	-75.1		Good
LPS	27.4	119	39	-16.6		Near
PDA	70.9	57	27	65.6		Doubtful
QUI	44.9	125	34.5	-29.1		Near
VAL	74.6	39	26	-80.0		Doubtful

December 3, 23^h, 22.4S, 69.3W, Chile (No Solution)

P Wave Data:

Compressions: ALQ BEC BHP DAL? DBQ GEO? GOL MHC PLM PRI QUI RCD ROL SCP WIN?.

December 3, 23^h, Continued

P Wave Data Continued:

Rarefactions: ATL? BLA? BKS CAR CLS LPS PAS SHS SPA TUL.

S Wave Data: N = 6

Sta.	Δ	Az	i_c	ϵ_o	Grade
ALQ	67.0	327	28	34.0	Good
BHP	32.7	341	38	0.0	Near
BLA	60.2	350	30.5	-33.0	Doubtful
CAR	32.8	4	37.5	27.0	Near
GOL	70.4	331	27	-27.0	Good
WIN	78.6	110	24.5	60.0	Good

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13. ABSTRACT
This is the second report of the S Wave Project, a routine program instituted by the Department of Geophysics of Saint Louis University for the determination of the focal mechanism of the larger earthquakes of each year using methods developed for the use of S waves in focal mechanism studies. In addition to the methods of data analysis described in detail in the previous report for earthquakes of 1962, in studying the earthquakes of 1963 use has also been made of a computer program. The program uses an error surface to search for the position of the axes of a double couple which gives the least standard deviation of the S wave polarization data.

Seventy-two earthquakes of magnitude $> 6\frac{1}{4}$ occurred during 1963. Of these thirty-five earthquakes, so located as to afford a distribution of seismographic stations favorable for the use of S wave data, were selected for examination. Satisfactory focal mechanism solutions are here presented for twenty-six of these shocks. Tentative solutions are given for six, and no solution is advanced for the remaining three.

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S Wave						
Polarization						
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